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New Series, Vol. VIII
Old Series, Vol. XXVII | *Chicago* | MARCH, 1912 | *New York* | No. 3

Special Articles in This Issue

American Railway Engineering Association - - - - - - - - FRANCIS W. LANE
Concrete Practice, C. M. & St. P. Ry.
Rio Puerco Grade Revision, A. T. & S. F. Ry. - - - - - - J. G. VAN ZANDT

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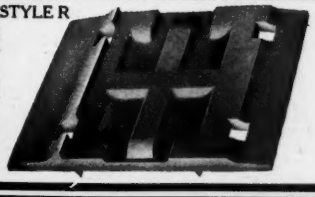

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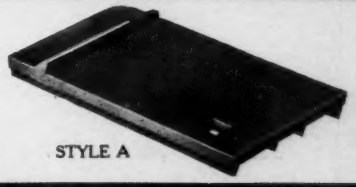

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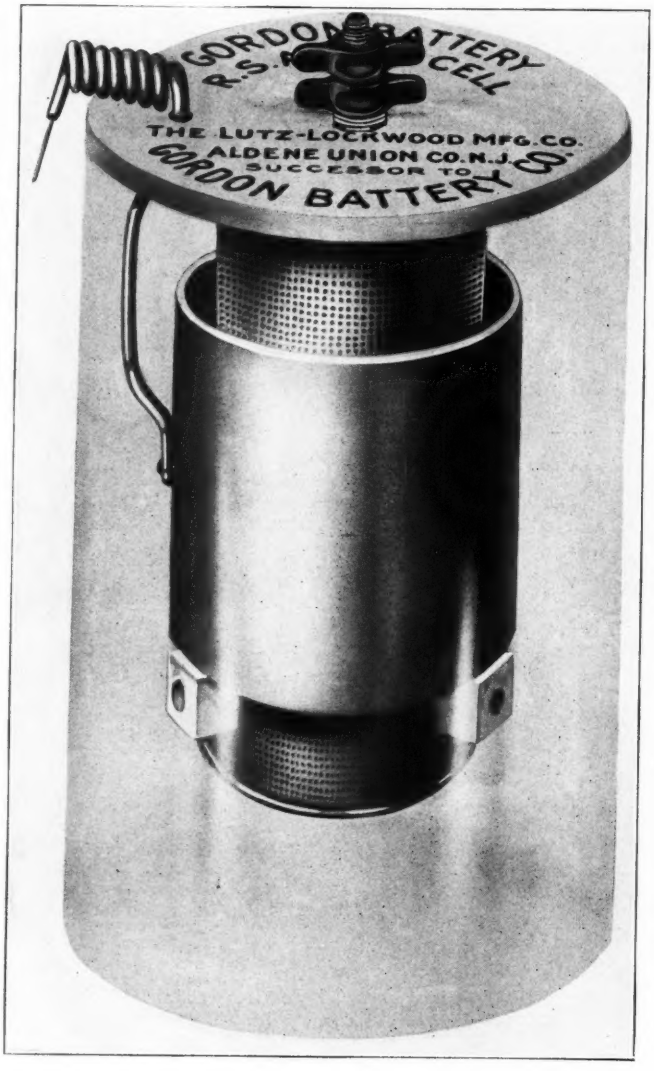

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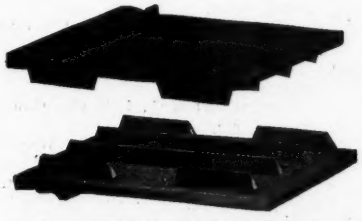

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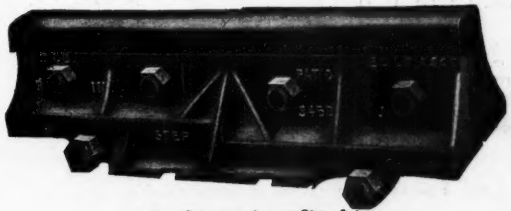

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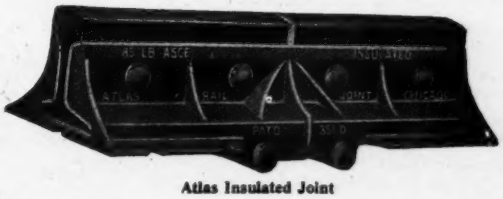

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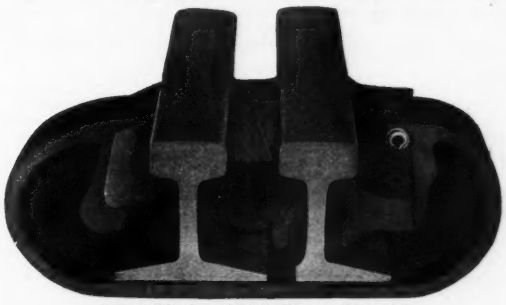

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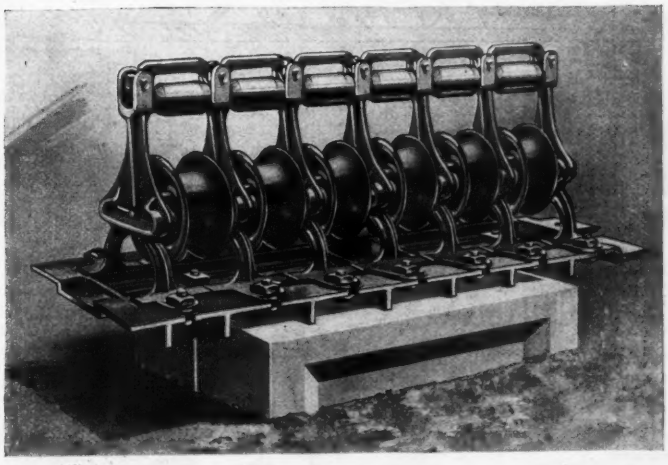

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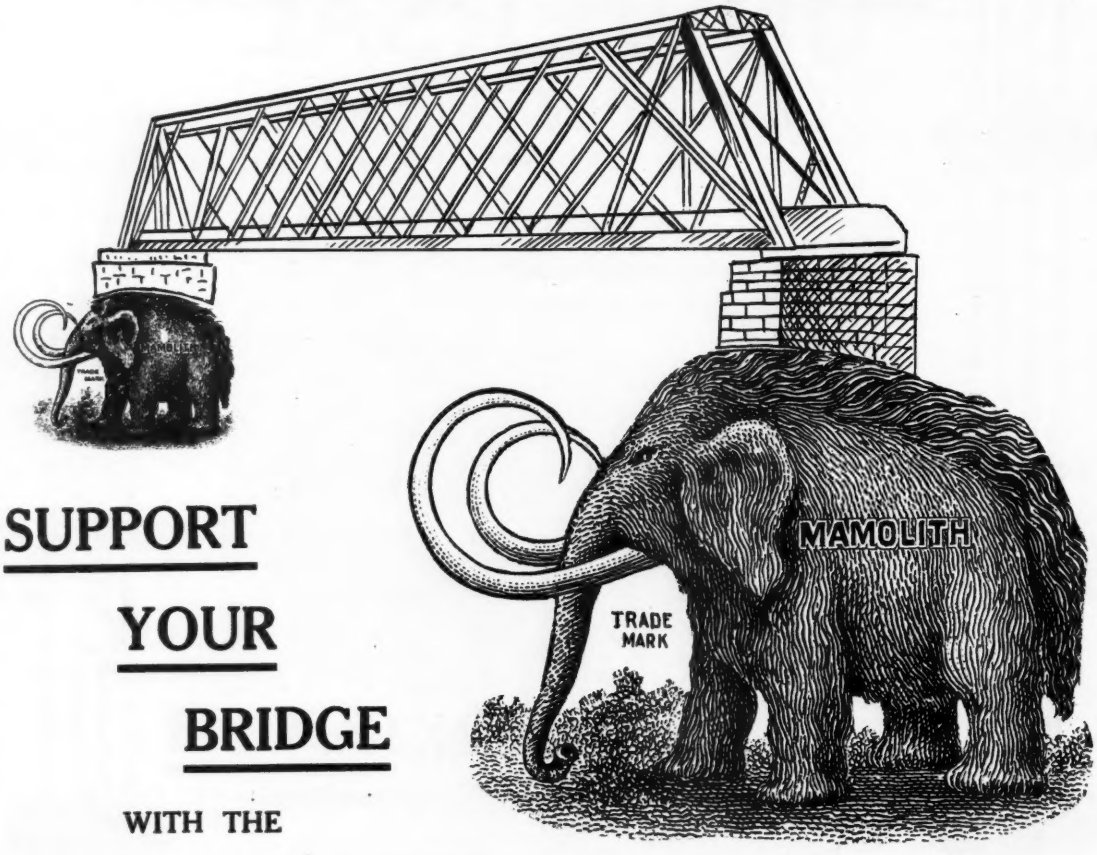

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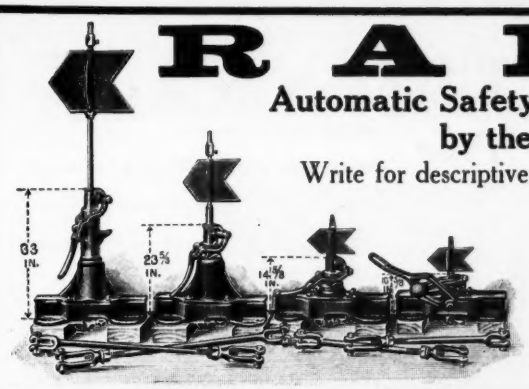

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Type A	for rail up to 100 lbs.	5½ Inches high	80 Ton Locomotive	3½ Ins.	145
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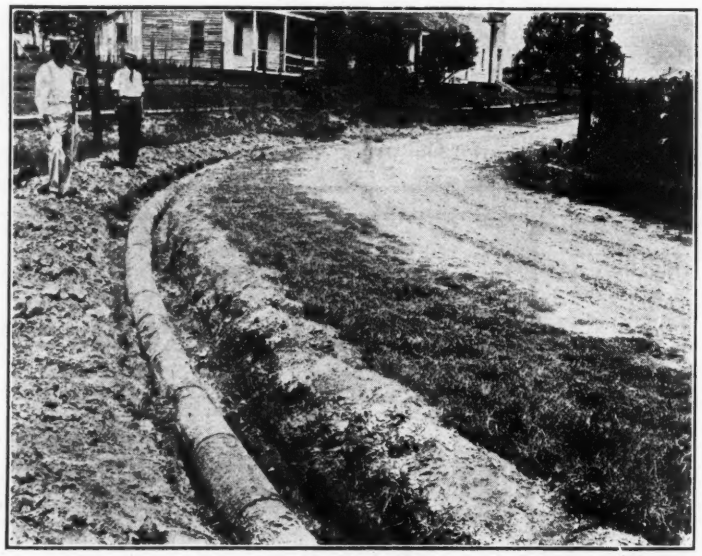

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Note abrupt curve made with short lengths of pipe

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Protects water from freezing.

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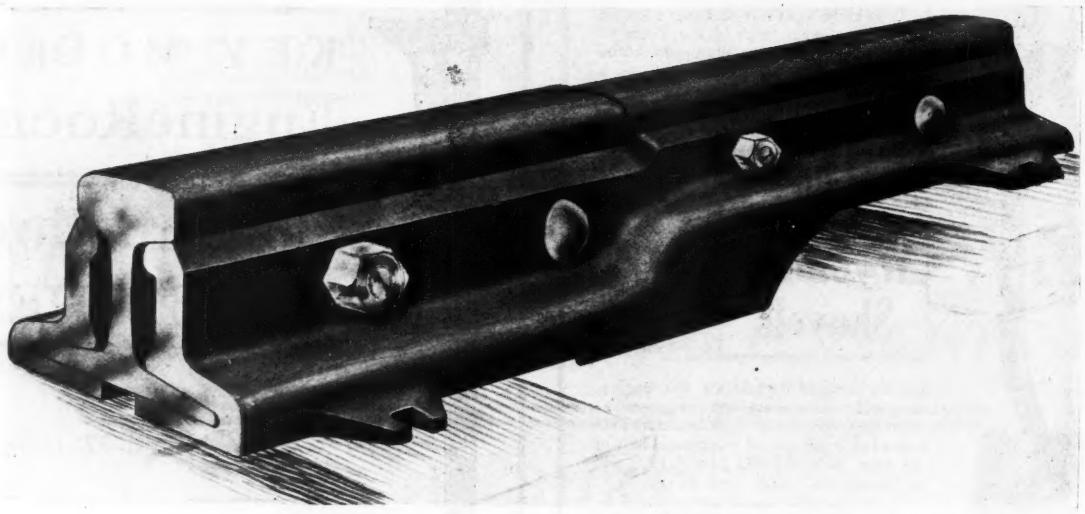

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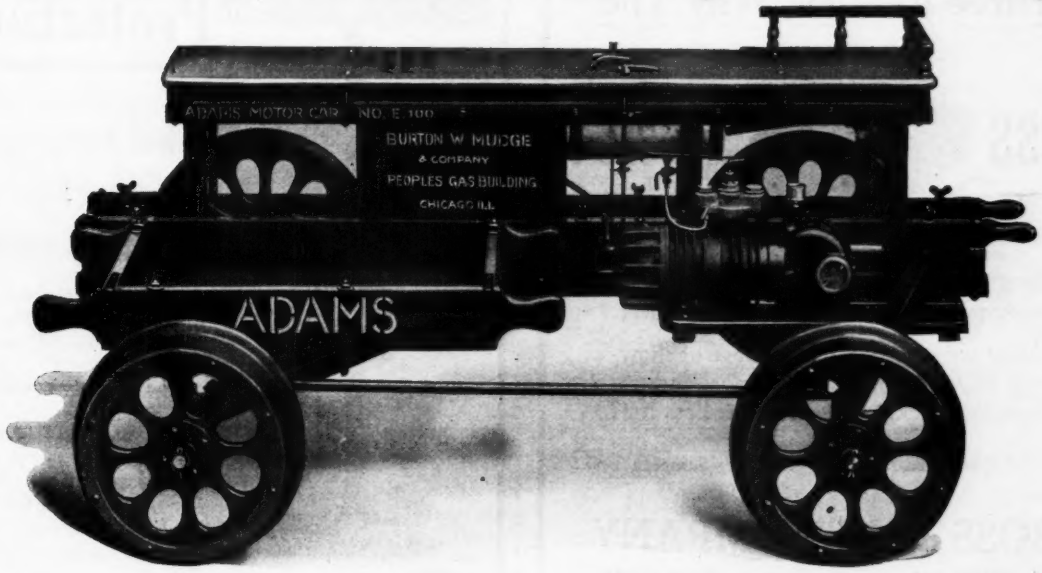

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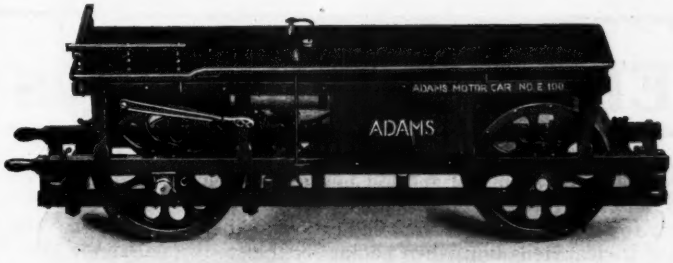

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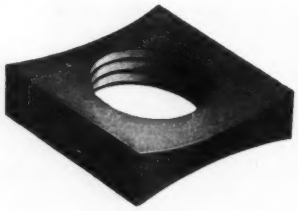
BOSS  **NUT**

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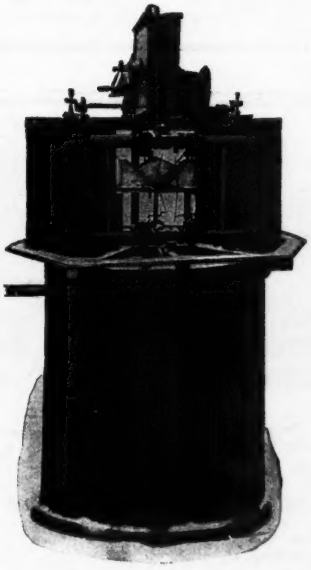

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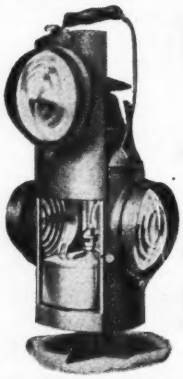
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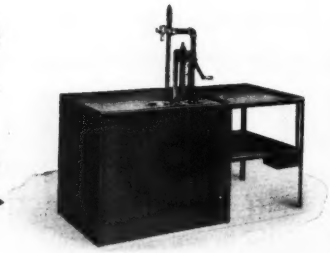

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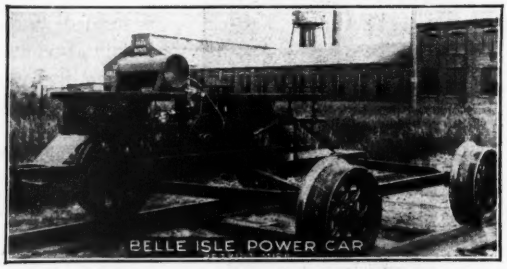

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American Water Softener Company

1015 Chestnut Street **Philadelphia, Pa.**

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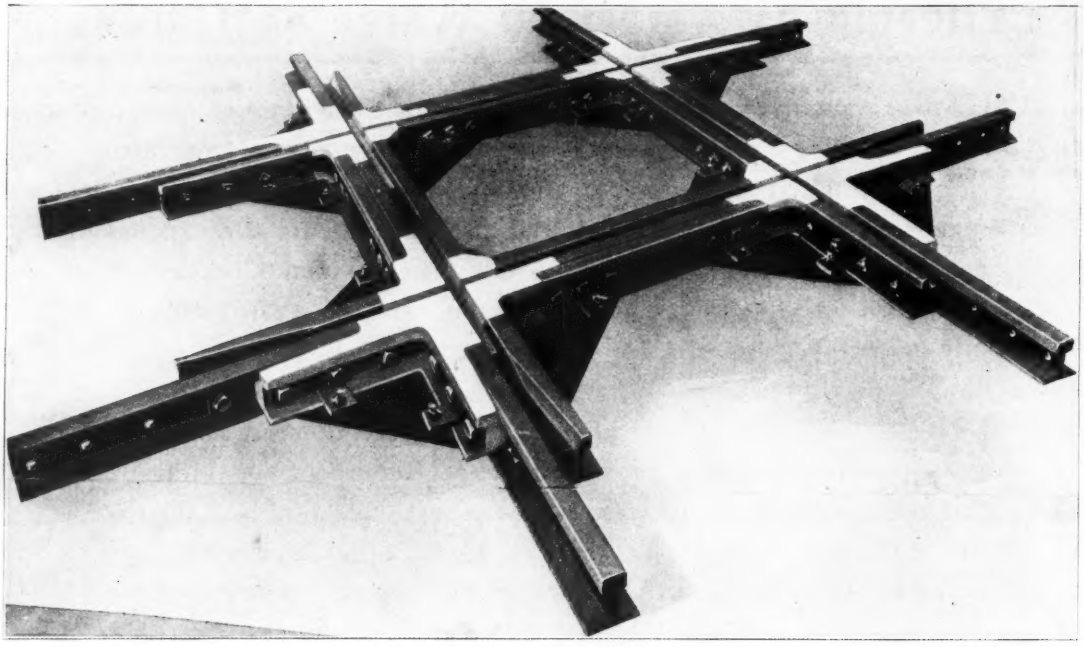
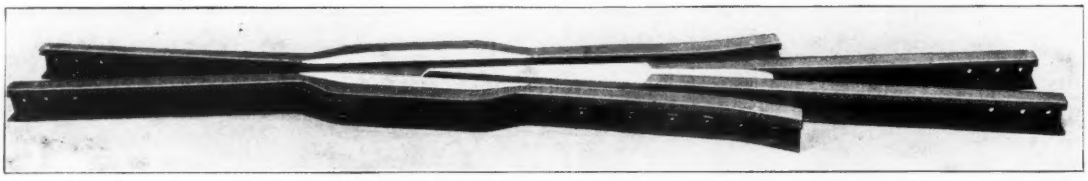


Showing construction with base plates. This design is three rail construction.

MANGANESE HARD CENTER FROG



WING rail pieces, throat point and heel blocks are one manganese casting. The entire wearing surface of this frog is so completely protected with manganese steel that it is especially adapted for use under the most severe traffic. The manganese insert extends beyond the binds of the wing rails in the throat of the frog.

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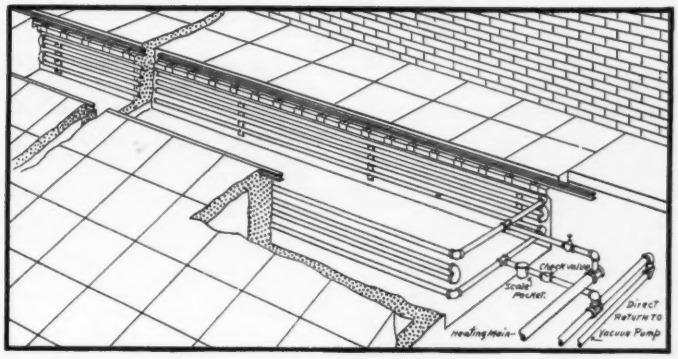

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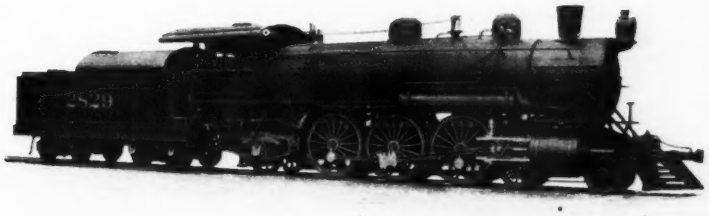

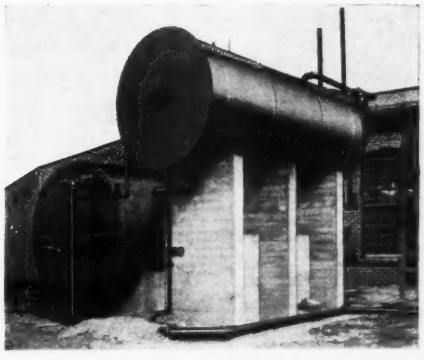

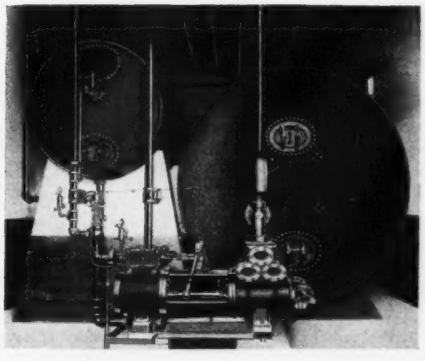

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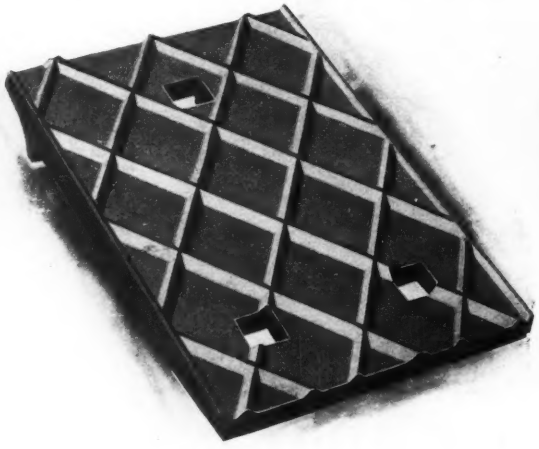
THE corrugations on the bottom compress and engage the top fibres of the tie but *do not cut them* as will flanges and claws on other plates. Water and foreign substances therefore do not enter into, rot and destroy the wood.

A firm grip is taken on the tie and track is *held to gauge* on the sharpest of curves and under the most severe conditions.



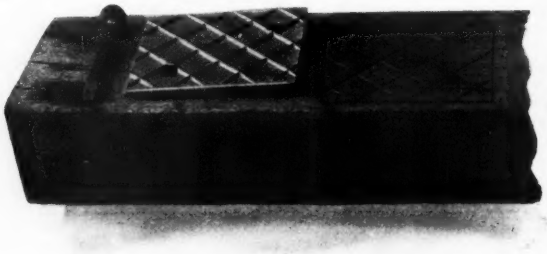


Plate and tie (white oak) in track on main line 5° curve under heavy traffic for four years.
Impressions on the tie show that plate *has not moved* from its original seat.
Both plate and tie are in *perfect condition.*

"SELLERS TIE PLATES are rolled at Chicago for Western delivery, from *New 600 lb. Wrought Iron Billets,* and at Pittsburg for Eastern delivery, from new steel *Bessemer* or *Open Hearth Billets."*

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Plates are made in various sizes and punched with two, three or four holes to fit any section rail.

Trial lots will be supplied free of charge

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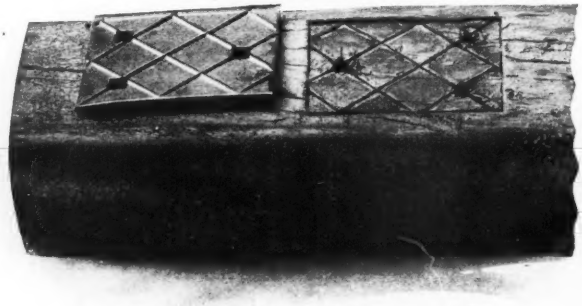

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Adzing and Boring Ties.

ADZING AND boring ties before treating is being advocated by a good many persons interested in the question of tie preservation. An argument in favor is that a penetration of the preservative is obtained where needed most, that is, in the wood immediately surrounding the spike.

Investigators have shown that there is an excessive mutilation of wood fibres when the ordinary spike is driven into a tie. If a hole is first bored into a tie, the spike, when driven, is constrained to follow the hole and will not mutilate the fibres to nearly so great an extent as when no hole is bored. The spikes will not be deflected by knots as they are liable to be when driven direct, and the spike being constrained to follow the hole, it is more likely to be driven straight and snug up against the rail, even when driven by an inexperienced man. We must concede in the first place that the holes are bored correctly, with proper spacing. When handling a large gang of men, considerable advantage would be gained in having spikes driven straight without the constant and detailed supervision which is now so often required. The number of spikes which could be driven per man would be considerably increased with bored holes; this advantage would be very marked where thoroughly seasoned white oak ties are used.

From a wood preserver's standpoint the same argument holds for adzing ties as for boring ties. No part of the treated wood should be removed, as that part beneath will be nearer the air and will not have maximum protection. If the ties have been treated to refusal, and a perfect penetration obtained, no advantage for adzing before treatment is apparent from this point of view. But such cases are in such small proportion as to be negligible.

From the laborer's standpoint we find an advantage in both adzing and boring hardwood ties, whether they be treated or untreated. The rail seat of a tie rarely requires adzing under more than one rail. In order to get the one rail seat adzed correctly, it is necessary to have the opposite end spiked solidly with a good rail bearing, and then the opposite end can be adzed to fit the rail base. Adzing under a rail in this manner is very expensive, and sometimes it is almost impossible to adz off the tie without raising the rail. With a machine for adzing and boring ties, we not only secure the benefit of machine work, which is cheaper, but the tie being adzed is in a much more convenient place to work on. The work is also more accurately done, giving a more uniform rail seat with resulting advantages.

The great objection to boring ties is that the exact size of of the rail must be known where each tie is to be laid, and furthermore, as ties are usually replaced in spots, an allowance must be made if the gauge is wide (on account of rail wear, or for any other reason). Otherwise the gauge must be corrected wherever it is not exact, even if the gauge is uniform over a long stretch of track. The latter objection would not be serious on tangent, provided the rail was correctly laid and maintained.

High class main lines would be the first place where machine adzing and boring ties would be justified, just as it is in such places that the use of treated ties is justified. In such track most railways are now using 90 or 100 lb. steel almost exclusively. For adzing and boring ties for such track, not

over two sets of differently bored ties would be required. On some railways practically all important main line would be fitted by ties bored in the same manner.

We have heard some criticism of the bored ties, in which it was alleged that the width of the rail bases of different rails would vary as much as one-quarter of an inch, and that on this account constant trouble is entailed by their use. If this were true, the gauge of the track would of course be bad, with bored ties. While we have known the *length* of two rails to vary as much as one-half inch, we doubt that any perceptible variation is to be found in the width of rail base, and if such is the case it shows very poor rolling. In fact, rails with such a variation in width of base could not be called a standard section. One of the first rules that a trackman on location learns, is to distinguish different weight rails by the width of the base. From 60 to 65 lb. A. S. C. E. rail the width of base increases from 4¼ to 4⅜ inches, or only ⅛ inch. If there was a variation in width of rail bases, of rails of the same weight, the difference between these two sections or any other two sections would be hard to determine in the above manner, but such is not the case.

It has been customary on some railways to drive flange tie plates to a bearing in the ties at the shop with a steam hammer, using a plate-gage or template to mark the correct location of the plate. No particular trouble was encountered in using such ties. In the latter case, as well as in the case of boring spike holes, it is necessary to know how many ties, size of rail, and other particulars for each section or division. This might have been difficult in the past, but should not be difficult on the railway of today with its highly organized departments.

Employers' Liability Decision.

THE EMPLOYERS' liability law, enacted by Congress in 1908, was declared constitutional by the Supreme Court in a decision handed down during the middle of January. The law of 1908 took the place of one previously passed by Congress but declared to be unconstitutional. The decision as to the present law, however, was unanimous and the law supersedes all state legislation covering the same field as applied to interstate commerce. It makes the employer liable for accidents caused by the negligence of an employee (the fellow servant doctrine), and greatly curtails the defenses of the employer in the cases of "contributory negligence" and "assumption of risk." The decision of the Supreme Court is positive and plain in stating that Congress has the right to enact legislation defining the liability of carriers engaged in interstate commerce.

Legislation of this sort has been enacted in practically all foreign countries and it must eventually result in good, not only to the community at large, but to the carriers as well. About a fourth of our states have laws limiting the old time defenses of the employer and the right to do this has now been firmly fixed by the highest court of the land. The railroad employee is a part of the company; now more than ever is the company responsible for its employees. The past month saw the appointment of a superintendent of safety on the Burlington; twenty years ago a superintendent of safety would have been about as logical as a superintendent of swearing. By this time most of our roads are doing organized work towards the propagation of safety. The Chicago & North-Western has the slogan "Safety First" and it might well have made it "Safety First and Always," for railroads are operated to make life of more value and not of less value. A number of roads in buying machine tools make the item of safety one of the important points to be considered, and now that the employer's liability is increased, it might be well to note that it is up to machine tool builders and others to see that their products have been made as safe as possible, and to let their customers know it. The machine tool which is efficient and at the same time is safeguarded is bound to command the interest of those making railway purchases.

However, a stricter definition of employers' liability does not necessarily mean a more efficient system of workmen's compensation, for under the national law, though the rights of the employee are more firmly established, the court must, in cases of last resort, fix the amount of compensation. A bill providing for a definite scheme for workmen's compensation, which is now being worked out by a joint committee of Congress, should go hand in hand with the federal employers' liability law, as it does in a number of the state acts. It will allow the carriers to know just how much they are liable for, and it will allow the employee to know what he may expect. As it is, he who needs compensation most, is least able to fight for what he should have. The recent decision puts this sort of legislation on a firmer basis and should clear the way for a comprehensive scheme of compensation.

Barking Ties.

EXPERIMENTS at the Forest Products laboratory, Madison, Wis., have shown that bark is very impervious to water. This characteristic varies with the kinds of woods, and it was demonstrated that a piece of bark not much thicker than a piece of paper, on one stick of wood, prevented any penetration of preservative under very high pressure. This brings us back to a question on which there has been some disagreement among trackmen. It has been held by a great number that all ties (meaning especially untreated ties) should have the bark removed or should be "peeled" before they are placed in the track. On the other hand, the opponents of this stated that in removing the bark, the very protection which nature had provided to resist the entrance of water, etc., was being destroyed.

When a cedar or hemlock tie is put into the track with the bark on, it occasions quite a good deal of difficulty when resurfacing. After being in the track for some time, the bark gets loose from the tie, and it is difficult to tamp well, unless this bark is removed. However, the part of the tie back of the bark is usually found to be hard and sound. It is possible that the difficulty experienced later in removing the bark from the ties in track, has helped establish the custom of peeling ties before using them in track. Then there is the seasoning question which may determine very largely as to whether or not the bark should be removed.

Recent developments then, show that there is some justication for those who advocated leaving the bark on the ties. However, there are undoubtedly many kinds of timber where little good would result from leaving the bark on, for instance on those timbers with longitudinal cells, where practically all moisture penetrates from the end.

It is a known fact to all wood preservers that the sapwood is the part of a stick most easily impregnated; or in other words, the sapwood is the most pervious to moisture, air, etc. It is in the sapwood then that we would expect the first evi-

dence of decay, and herein lies a justification of the practice of laying ties sap side up. When decay occurs it should first appear on the top where it is easily detected, and not underneath where very serious rot might occur without being detected.

Edison and Railway Electrification.

THOMAS A. EDISON has advanced a plan for electrifying crowded railway terminals by means of the storage battery system. If newspaper accounts are to be credited, his assurances of the success of his system have been of the boldest, and two railways have tentatively agreed to a trial. After a conference with Illinois Central officials, Mr. Edison freely gave information to Chicago newspaper reporters to the effect that several locomotives would be built to operate on the storage battery principle and placed in service on that road in its Chicago terminal. The inventor plans to use a tender to carry his batteries much as steam locomotives haul water and coal. These tenders will be charged at a charging station and picked up by the locomotives as needed. It is stated that the batteries to be used can be charged in one hour or less, and that the power of the locomotives can be made equal to those of the largest steam locomotives in service. The Edison-Beach car, which will be tried out by the Chicago Great Western for branch line service, is equipped with batteries which cannot be charged in so short a time by several hours.

Owing to Mr. Edison's no less than marvelous success in past years as an inventor, he is looked upon by the masses of the people of this country as no less than a wizard and consequently his assurances of the success of his latest efforts are credited by them to the fullest extent. Owing to this fact, and following Mr. Edison's statement, small sympathy is extended, by the people who are behind the movement to push the electrication of terminals, to those conservatives who wish something more than bare assurances before taking a radical step of this nature. It seems hardly possible that even Mr. Edison, after such a superficial insight into the local situations, has not underestimated the difficulties incident to the change of motive power. Perhaps it might have been more satisfactory all around if the engineers now engaged in the study of the subject of the electrification of the terminals at Chicago and other points, had been given a chance to go into Mr. Edison's plans thoroughly before the unreserved assurances had been made public.

Ideas Purchased.

SOME TIME ago the Pennsylvania Company announced that it would pay its men for valuable ideas. The first results of the experiment have just been made public. The response was immediate. As was expected, the men in charge of minute detail saw ways of increasing efficiency which escaped the general directors of the work. Suggestions came in from all quarters. Many of them proved to be of real value and their authors were rewarded in cash.

A clerk in one of the roundhouses won a premium by submitting a plan for increasing economy by the further use of carbon sheets which remain in repair card books, after the cards have been filled in and removed. He devised a way of using this carbon paper in connection with one of the company's forms for ordering material from the store houses.

Another of the schemes considered worthy of remuneration came from a tinsmith in one of the shops. He discovered an improved method for fastening in engine cabs the boxes which contain flags, torpedoes and medical case. By standardizing the heights of coal gates on locomotive tenders, a fireman saw a way to minimize the loss of coal through vibration. He was paid for the idea.

At one of the terminals, an appliance for cleaning and sterilizing drinking cups used in coaches was perfected by a car inspector whose duties are in connection with the care and equipment of passenger cars. It was an undoubted improvement over the old method and its originator received payment for it.

Although a great many worthless suggestions come in, officials say that the saving effected by those which are adopted makes it very much worth while to investigate them all. Aside from these direct benefits, there is much indirect gain in the added interest employes take in their work, and in the watchfulness and originality which is developed.

The Santa Fe de Luxe extra fare train between Chicago and California has buffet and dining cars equipped with Duntley air washers. These washers, which are electrically driven, take in air through a vent in the deck. The dust and cinders are removed in the washers, and the air is then forced into the cars through a series of ventilators placed just beneath the deck sash. The washers are packed in ice and the apparatus is another step toward better ventilation in our cars.

Concrete.

The following, clipped from a railway employes magazine, may explain why the Portland cement companies have been conducting a vigorous educational campaign on the properties of cement and concrete.

"During last season the ——— Concrete Company has been operating a plant for the manufacture of immense concrete tile at ———. These large tiles are used by the railway company for culverts and are shipped out of ——— in all four directions. The location of the plant is thus very favorable, and plenty of good sand is to be had at the river about a mile south of ———. The large tiles are run in forms of wood. The cement and sand mixture is made by machinery and the tiles are reinforced by a network of square, stiff wires. The mixture is run into the molds and allowed to set, when the tile is removed and kept well wet down for about a week, being soaked with water usually morning and evening. The amount of water taken up by these tiles is surprising. They seem to drink it up like a sponge. The wetting down has a great deal to do with making the tile tough and strong. These tiles weigh about three tons each, and nine of them make a carload. They are handled by derricks, of course, with steam power. This season the plant here employed about twenty men, and made a thousand tiles. The plant will be operated here again at about the same capacity next season."

We infer from the above that the best concrete is that which will absorb the most water. After a good deal of study we decide that a "network of square stiff wires" is wire net reinforcement. The "machinery" which "makes the mixture" is probably a concrete mixer. We also assume that there must be a good heavy deposit of sand in order to make concrete which will absorb water as above.

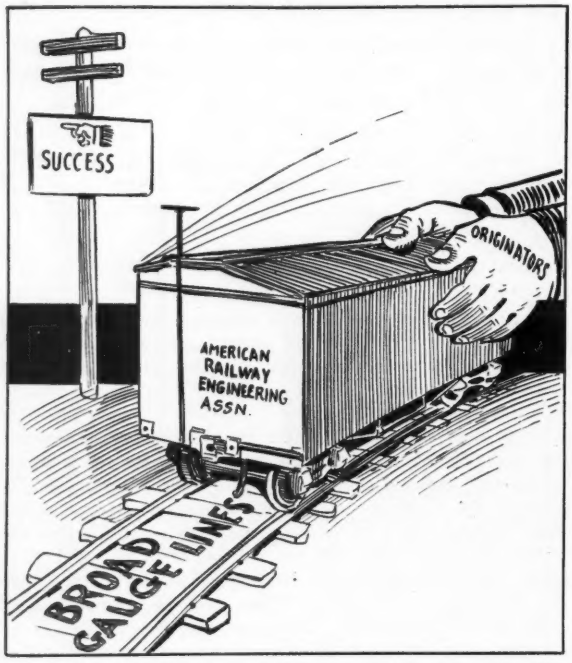
We expected to read that there were also heavy deposits of Portland cement somewhere near, but if the description is anywhere near the truth, and the tiles absorb water as indicated, the "deposits" of cement must be exceedingly light in the concrete.

The American Railway Engineering Association

Some Notes On Its Early History. Its Personnel and Its Work.

By Francis W. Lane.

When on October 21, 1898, a little group of men met in one of the club rooms off the main stairway of the Auditorium hotel and effected a preliminary organization of what it was determined to call The American Railway Engineering and Maintenance of Way Association, the most far-sighted among them would have been slow to predict the rapid and efficient growth that has characterized all the subsequent years of its life. As a matter of fact some hesitancy was expressed, not as to the need of such an association, but as to whether railway engineers would come in sufficient numbers to enable it to accomplish the work its sponsors had tentatively laid out for it. That the association in subsequent years and almost at a bound assumed and has maintained a commanding position among railway associations and engineering societies may be admitted with no discredit to the later membership to be due largely to the work of those who started it off on broad lines and maintained from the outset the interest of engineers who became members and enlisted the attention of those who were or might subsequently become eligible to membership.



Why the Association Has Maintained a Commanding Position Among Railway Associations.

On the Job Since the Association Was Organized.

And there are scores of others who have contributed of their best to the proceedings. Some of these are the younger assistants in engineering offices whose names do not even appear on the roster of the membership, and yet whose work has contributed materially to the standing of their chiefs before the public. There are others, more facile with the pencil, the slide rule or the formula than with the organs of speech, who have silently and laboriously delved and yet gladly have thrown in their contributions to the general effectiveness of the organization. Some of these have done quite as valuable work behind the scenes as those who have been more conspicuously in the limelight. It is said that there is a place where all these shall receive their reward. May it indeed be so.

Though a part of the permanent records of the association, it may be of interest to chronicle here the names of those who attended the meeting for preliminary organization on October 21, 1898. They were the following:

H. A. Kennedy, general superintendent, Cleveland, Canton & Southern.

F. E. Paradis, chief engineer, Chicago Terminal Transfer.

C. Dougherty, roadmaster, Illinois Central.

G. W. Merrill, roadmaster, Chicago, Milwaukee & St. Paul.

W. S. Kinnear, principal assistant engineer, Michigan Central.

G. W. Taylor, St. Louis Terminal Association.

W. E. Emery, roadmaster, Chicago & Northwestern.

E. C. Macy, division engineer, Iowa Central.

W. M. Duane, roadmaster, Cleveland, Cincinnati, Chicago & St. Louis.

J. B. Dickson, roadmaster, Chicago & Northwestern.

L. C. Fritch, superintendent, Baltimore & Ohio Southwestern.

C. A. Wilson, chief engineer, Cincinnati, Hamilton & Dayton.

G. S. Cheyney, general roadmaster, Indianapolis, Decatur & Western.

H. W. Church, roadmaster, Lake Shore & Michigan Southern.

G. H. Bremner, assistant engineer, Chicago, Burlington & Quincy.

A. Torrey, chief engineer, Michigan Central.

Harry P. Robinson, editor The Railway Age.

The writer was also present, but merely in the capacity of chronicler of events.

It may not be generally known, except in fact to a few of the older engineers in point of membership, that the call for the preliminary meeting referred to was prepared one year prior to its issuance. It was hoped by those actively concerned in the initial movement, that the Roadmasters' Asso-

ciation, formerly an organization of considerable influence in maintenance of way matters, would make such changes in its constitution as would enable it to become the nucleus of the new organization, thus uniting the parts of the work loosely classified as theoretical and practical, bringing the engineer and the roadmaster into closer touch and avoiding a multiplication of railway associations. But the Roadmasters' Association at its Denver convention—by a vote of 47 to 45, if memory serves—determined to pursue the course it had previously followed. Its members—a majority—were roadmasters, and such they would remain. Most prominent among those supporting the movement to admit engineers as such into the Roadmasters' Association, were Frank R. Coates, then roadmaster of the New York, New Haven and Hartford, later chief engineer Chicago Great Western, and G. W. Merrill, then roadmaster of the Norfolk & Southern.

In view of the failure of this movement, the following circular was addressed to the officials of railroads of the United States and Canada:

"It has been suggested that a movement be inaugurated for the organization of an association of railway officers connected with the engineering and maintenance of way departments. Nearly all the other branches of the service have their representative associations, which are of undoubted value in their respective provinces. In the engineering and maintenance of way departments, however, there is no organization between the general engineering societies and technical organizations that can adequately cover the field.

"The new association, whatever its name might be if organized, would include all officers interested in the construction and maintenance of the track and roadway and the structures associated therewith, whatever the titles of such officers might be on the individual roads.

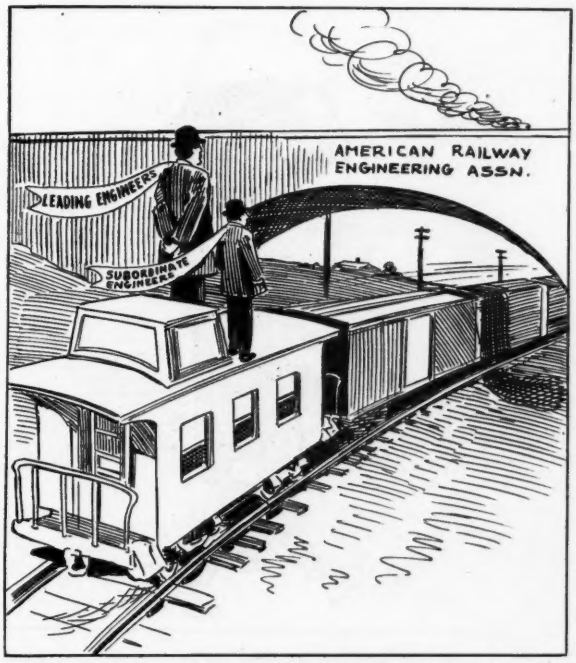
"Would you join such an organization if properly organized, and would you endeavor to attend a preliminary meeting if called to meet in Chicago at some date in the near future?"

Many responses were received, some enthusiastic, some displaying hesitancy, or at least a desire to know more about the matter before committing themselves, but on the whole so favorable as to warrant the calling of a meeting for preliminary organization as above stated. The then editor of the Railway Age, Harry P. Robinson, read the letters received in response to the circular, which he had been asked to issue, and a temporary organization was effected with the late Augustus Torrey, chief engineer of the Michigan Central, as chairman, and L. C. Fritch, then superintendent of the Baltimore & Ohio Southwestern as secretary.

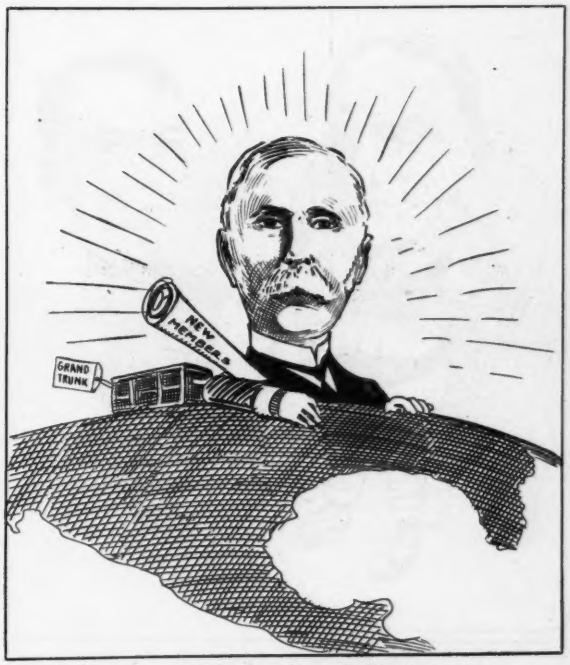
There was much discussion as to the name of the new organization. It was felt that the success of the movement depended upon making the proposition an attractive one to the more prominent members of the railway engineering profession and in making the name broad enough not to frighten out of the ranks subordinate officers who were then associated with one or another of the subdivisions of railway engineering and maintenance of way work. Finally, unwieldly as it was, the name under which the association has lived and developed until the change determined upon last year, was chosen.

The personnel of the committee appointed to prepare a constitution and by-laws may be better understood if it is remembered that the supporters of the initial movement recognized that possibly the entire and certainly the immediate future of the organization depended upon the professional standing of those under whose auspices the movement was introduced to its section of the public. The chairman appointed, as a committee to prepare a constitution and by-laws, John F. Wallace, then assistant second vice-president Illinois Central, chairman; P. Alex Peterson, then chief engineer Canadian Pacific; Thomas Rodd, chief engineer Pennsylvania Lines west of Pittsburgh; C. H. Hudson, chief engineer Southern Railway; W. G. Curtis, engineer maintenance of way, Southern Pacific.

Although the life of the association has covered so few years, only one of these men now occupies the same position. Wallace left the railroad service and later became chief engineer of the Panama Canal. Since his retirement



Making it Broad and High Enough for Both Prominent and Subordinate Engineers.

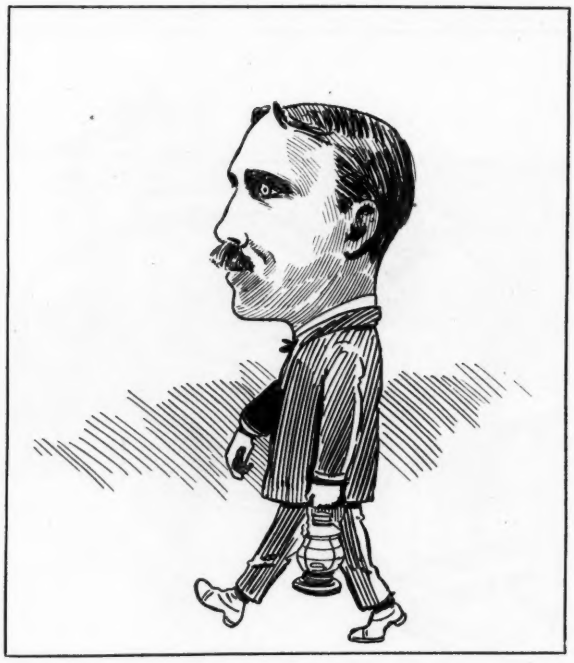


Another Who Loomed Up From the Northern Horizon.

from that service he has been engaged in private enterprises, largely in connection with the Westinghouse companies. Peterson retired from active service and became consulting engineer of the road with which he had served since 1890. Rodd alone holds the same position as in 1898. Hudson left the Southern shortly after the date named. Curtis, whose professional ability and practical experience promised so much for the association, not only because of that ability and experience, but because he was eager to devote them both unsparingly to its interests, was taken away untimely on June 15, 1900.

It would not be fair, however, to fail to mention that the mantles of these men, great in their line, have fallen upon shoulders of men worthy to wear them, and that the latter have recognized the value of the heritage so far as this association is concerned. Baldwin and Fritch filled the gap in the representation of the Illinois Central, not only by their own untiring work for the organization, but by bringing into the fold most of their subordinates who were in any way connected with maintenance of way work, while Harold U. Wallace, his father's son, and W. J. Harahan, for briefer

Keeping it in the Family.



Seeking for the Truth.

periods worked for and with the association. J. G. Sullivan's broad experience, strong personality and ready wit made a deeper impression than the retiring disposition of Peterson was ever able to effect. Tye, also, should be named in this connection. Rodd has held his own. Hudson's brief period of influence in the association has been ably filled out by the genial and efficient D. W. Lum, the influence of whose real work the Southern organization has modestly permitted to be partially obscured by the title of chief engineer of maintenance of way until he left that road to become consulting engineer of the Norfolk & Southern. Curtis' place was taken and ably filled by Julius Kruttschnitt until such time as a change in the organization of the great system with which he was connected presented opportunities which lured him into a position unique in responsibility and influence upon American railways, and his mantle again in turn fell upon Isaacs. About this time, also, there loomed up from the northern horizon the form of one William McNab, as one McGuigan had before, but the pleasant recollections of these pleasing personalities are running away with the story.

Under the leadership of this strong body of men whose names were first given, a constitution and by-laws were framed and adopted at a meeting for that purpose held in Buffalo on March 30, 1899. A permanent organization was effected with these officers:

President, John F. Wallace, assistant second vice-president, Illinois Central.

First vice-president, P. Alex. Peterson, chief engineer. Canadian Pacific.

Second vice-president, W. G. Curtis, engineer maintenance of way, Southern Pacific.

Treasurer, W. S. Dawley, chief engineer, Chicago & Eastern Illinois.

Secretary, L. C. Fritch, superintendent, Baltimore & Ohio Southwestern.

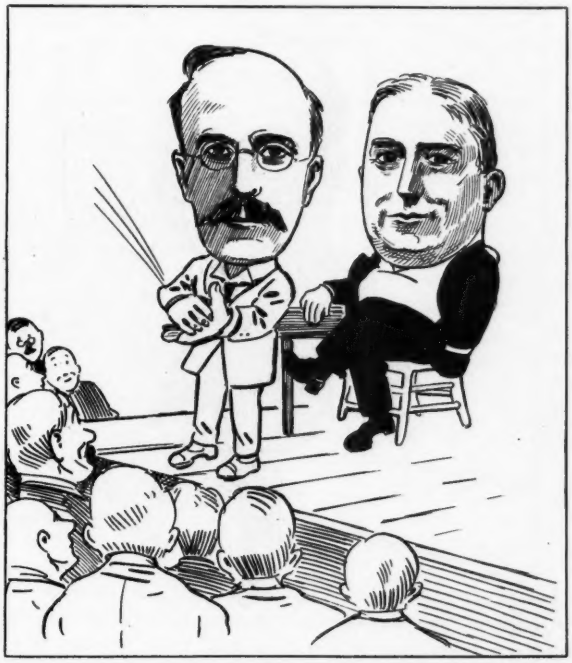
Directors, Augustus Torrey, chief engineer, Michigan Central; Thomas Rodd, chief engineer, Pennsylvania Lines west of Pittsburgh; D. J. Whittemore, chief engineer, Chicago, Milwaukee & St. Paul; F. H. McGuigan, superintendent, Grand Trunk; W. K. McFarlin, chief engineer, Chicago, Rock Island & Pacific; Hunter McDonald, chief engineer, Nashville, Chattanooga & St. Louis.

An imposing list, particularly when considered in connection with the work they were able and glad to do then and subsequently for the association. Torrey was taken away so soon (August 20, 1902), as to allow him little opportunity to participate in the work of the organization of which he was first president; Rodd has seen it all, and at least in the persons of his near associates, Richard Trimble and W. C. Cushing, has been a large part of it; Whittemore, by reason of advanced age allowed Loweth to bear the burden of associational work; McFarlin was active for a certain period; Hunter McDonald has from that day to this been a very vital part of the organism, and his strong common sense has been of quite as great value to his fellow members in convention assembled as his earnest and persevering seeking after truth in season and out of season in his profession. To quote his own words when he was elected to the presidency,

he has been the "hell-roarer of the Great Smoky Mountains." Fritch, with the able assistance of his brother, the present incumbent of the office, held the position of secretary until 1906, and later he was elected to the presidency; and Dawley took charge of the financial affairs until a change of location induced him to resign the position.

The first year of the association's existence was largely taken up in arrangements to perfect the organization, the establishment of standard subjects, the formation of standing committees and the selection of chairmen for them, and in building up the membership. How well this was done is probably best attested by the vim, unparalleled in the history of new organizations, that characterized the proceedings of the first annual convention held in Chicago on March 14 and 15, 1900. No small measure of the success with which the new association started off is due to the great ability as presiding officer of John F. Wallace.

It is obviously impossible in limited space to consider in great detail the history of the association down to the present time. Any account, based largely as is this, on personal recollections and knowledge of the writer, must necessarily



Two Prominent Members Offering a Few Thoughts on How the Association Should Carry on Its Work.

be superficial and fragmentary. One thing stands out conspicuously: The association has invariably honored itself as well as its selection in the choice of its presiding officers. Wallace, Kittredge, Kelley, Johnston, Berg, McNab, Fritch, Cushing—able leaders of able men. Many of the presiding officers held for two terms; Johnston declined re-election and Berg was removed by death (May 12, 1908) less than two months after his election. In its selection of members of its Board of Directors, which from the nature of the organization exercises so great an influence over its affairs, the association has been particularly fortunate. One of the early members whose name has not before been mentioned, A. W. Sullivan, then general superintendent Illinois Central, and until recently general manager Missouri Pacific, exercised both in the board of direction and on the floor of the convention, a vast amount of skill in advising the turning of the work of the association into a concentrated effort rather than predicating efficiency upon a scattering fire that might cover a vast territory but be productive of unnecessarily limited results. He was the first to propose in the Board of Direction what has since grown into the Manual of Recommended Practice—a bottling up, as it were, in plainly labeled receptacles, of the combined and concentrated wisdom which had been squeezed out of a vast amount of private investigation and the interchange of personal experiences. The proposition was revived by Berg and finally adopted as a permanent record of principles of practice developed by the association.

Along these lines was a feature which came up prominently at the fourth annual convention. In response to a request from W. C. Cushing, President Kittredge offered a few thoughts on how the association should carry on its work. Said he: "We are all thoroughly convinced, or if we are not, we ought to be, that we have got to follow some different plan to accomplish all we set out to accomplish. We have either got to set out to accomplish less and get done with it, or follow some other methods of accomplishing what we endeavored to do at this meeting." A long discussion upon the matter was crystallized by Mr. Berg in a resolution in the following words:

American Railway Association Refers the Entire Matter of Rails to the American Railway Engineering Association.

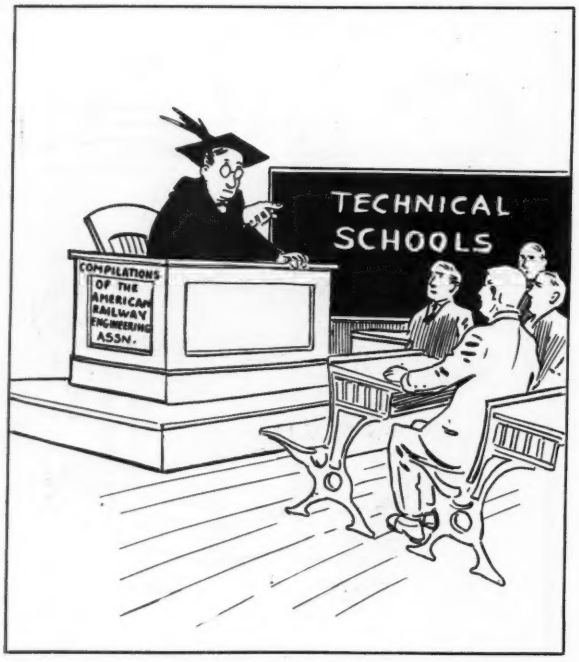
"It is desirable for the Board of Direction to consider the question of appointing a standing committee on standard specifications and definitions, whose duty it shall be to prepare final standard specifications and definitions, based on the adopted reports of the various existing standing or special committees on investigation, presented heretofore or to be presented hereafter to the association; the work of this committee to be in the nature of a board of review or revision, so that it can present to the association uniform and complete specifications or lists of definitions which, if adopted by the association, shall be known and published as the recommended standards of the association."

The Manual has made available a vast amount of information not otherwise obtainable in addition to crystalizing the features to which the association has given its approval.

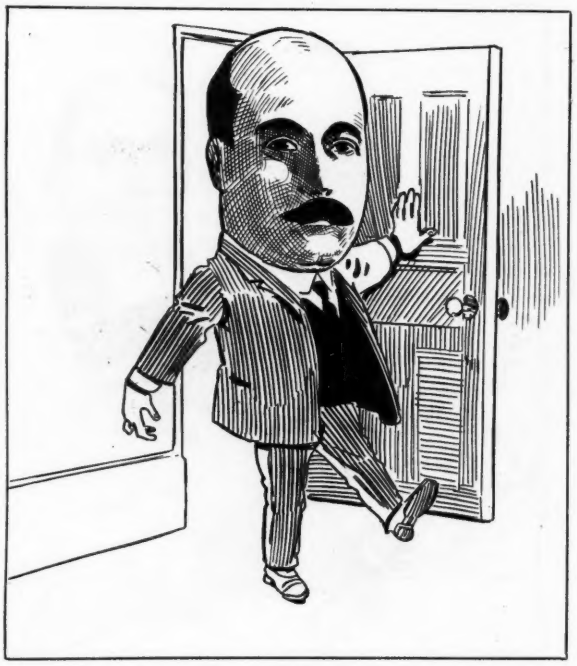
Probably the standing of the association may be briefly indicated by reference to a few instances of its work in particular lines and to the recognition that has been given them.

Its specifications for iron and steel structures are standard all over the country and the reports of its committees upon that subject are in use as text-books in most of the engineering schools of the country. In the city of New York all buildings using steel reinforcement must be built in accordance with these specifications. For three or four years exhaustive investigations were made by Prof. Turneaure, of the University of Wisconsin, Prof. Crandall, of Cornell, and others to determine the effects of moving loads upon steel bridges. More than $10,000 was expended in the investigations, and the results of them, published in book form, constitute the most elaborate work in existence upon the subject.

The American Railway Association has referred the entire matter of "Rails" to this association. The report of the committee last year, comprising nearly 600 pages almost solidly data, shows with what zeal the matter has been undertaken and pursued. Mention should be made in this connection of the great work of W. C. Cushing and M. H. Wickhorst, and in that upon structural steel of J. P. Snow, bridge engineer of the Boston & Maine, whose depth of



Regular Instructor in Many Technical Schools.



Has Anybody Here Seen—Murphy?

wisdom on the matter is equalled only by the modesty with which he gives his fellow members the benefit. Carruthers was the first chairman of the rail committee after the subject was referred over by the American Railway Association. Mr. Carruthers was also very active in getting new members for the association.

The engineer of the Washington Terminal Company has stated that he habitually keeps on his desk only two books, viz., the rules of his own company and the Manual of Recommended Practice. The government is to a large extent making use of the knowledge gained by the committees of this association in its work on the Panama canal and railroad; and while it is probable that the work would have been done had the American Railway Engineering Association never existed, it is doubtless equally true that the work is better done than might otherwise have been the case.

Sketchy and incomplete as these notes may be, they would be incomplete without reference to the monumental work of J. B. Berry, then chief engineer of the Union Pacific, on the subject of "Reduction of Gradient and Elimination of Distance, Curvature and Rise and Fall on the Union Pacific Railroad." This is recognized as the most complete and reliable exposition of the subject. This appeared in 1904.

There are now 18 standing committees of the association in addition to 11 special committees appointed to co-operate with similar committees from other organizations, or for special work. Many of these have been named incidentally. The Railway Signaling Association has been given much added dignity by the membership of its own members on the committee on "Signaling and Interlocking" of this association. Rudd, Anthony, Elliott, dean of the signalling faculty, Mock, Ames, Balliet, Hovey, Clausen, Stevens and many others have doubtless done more and better work by reason of their connection with the superior association.

In the history of the association from the start, the representatives of the engineering schools have borne no small part, and the resources of their laboratories have been freely used for the common good. Pence, formerly of Purdue, now of Wisconsin, has been associated in the work from its earliest days—conspicuously as editor of the association's publications; Allen and Swain, of Massachusetts Institute of Technology, have been most valuable members; Turneaure, of Wisconsin, and Taylor, formerly of that university, but later chief engineer of the Alton, and since deceased, have contributed valuable knowledge; Hatt, of Purdue, has furnished valuable data on ties; Talbot of Illinois, on concrete structures. Crandall's work has been mentioned.

There are many others who have done good and faithful work for the association. Many of them are doing it still, while others have been drawn away into other fields or other branches of the railway service. Kinnear was one of the first to put his shoulder to the wheel, and he has kept it there rather closely. H. J. Slifer started the roadway committee well on the course it has followed since. W. L. Breckinridge and C. H. Cartlidge convinced the membership that the interests of masonry on the Burlington were in good hands. William R. Webster has always done won-

derfully efficient service, sometimes with the support and sometimes with the opposition, of E. C. Brown, of the Carnegie Steel Company; T. L. Condron, of the Pittsburgh Testing Laboratory; F. E. Abbott, of the Lackawanna Steel Company, and many others. A. F. Robinson, Santa Fe, has added some valuable papers on bridge design and construction to the files of the association. Rose has helped out on track construction. Prof. Williams, to whose capable instruction many members owe much of their success, has been strong on ballast. Dr. Herman von Schrenk needs only the mention of his name to call up vast stores of knowledge on timber and its preservation, and the late Octave Chanute, though the work was far less spectacular than the demonstration of aeroplanes, gave the benefits of deep study on the same subject. C. S. Churchill has "come out strong" on almost any subject before the association involving a wide experience and solid sense. J. A. Atwood's retiring disposition would never allow him to become conspicuous on the floor, but it is probable that Raymer would be one of the first to acknowledge the benefit derived from association with him in his daily work. J. H. Prior is a new member, but his contribution to literature on the "Design of Bridge Abutments,' is one of the association's valuable papers. The same may be said of O. F. Selby's paper on Track Superstructure. A. S. Markley, I. O. Walker, F. E. Schall, W. F. Steffens and others have demonstrated the efficiency of an earlier training in organizations of a subordinate rank. W. B. Poland has been as active in association matters as locations in Alaska and the Philippines have allowed. G. A. Mountain and Duncan MacPherson have ably assisted in holding up the Canadian end. Wendt and Safford have spent weeks and months upon the subject which probably has less inherent attractions than any other on the list—"Uniform Reports, Records and Accounts." Tratman, with his love of accuracy, of close detail, and Camp, "sturdy and staunch," have bravely held up the honor of the technical publications and in a way that does not appear anywhere prominently, have done much good "editorial" work on discussions and in committee.

But in a record unsurpassed in general efficiency and zeal in any association, it is impossible to do even and exact justice in the selection of names. The allotted space is nearly exhausted.

Obviously, in a membership of a thousand or so, it is impossible to mention more than a small percentage by name, or to refer to more than a few of the specially noteworthy works. It would perhaps be unpardonable to do so much or so little as has already been done, were it not that the writer has been closely associated with the association since the day of its birth, has been in attendance at the meetings from the first preliminary up to the present, with but one exception, and, in it but not of it, has been privileged to sit and look into the faces of the speakers upon the floor at all of these meetings, and to assist in chronicling their work. It is a pleasure, even in this imperfect manner, to touch upon some of the matters that have come up within his knowledge and to recall some few of the faces familiar to him for the past fourteen years. Principal attention has naturally been given to the more historical elements and persons connected with the association rather than to the younger element of the membership so strongly coming to the front. If, however, these latter conceive that there is any value to them in such mention as this, or if they derive any satisfaction from being so mentioned, let them only emulate their predecessors who have been mentioned herein, and they shall not lack chroniclers of their doings nor recollectors of their personalities.

WHAT SHALL WE DO WITH THE TRUSTS?

By J. P. Colby, Public Accountant, Boston, Mass.

Just now everybody is talking about the trusts. All the spell-binders and the writers and the bankers and the statesmen, and even the politicians, are taking a hack at the much-mooted question, "What shall we do with the trusts?"

In the days before the advent of air brakes, there was once an engineer who knew how to run his engine perfectly well, taking fifteen carloads ot passengers, a hundred children in every car, 1,500 persons in all, to the annual picnic. The train struck a down grade and the heavy load of precious human freight was more than the engine could hold back, when suddenly far down the track appeared a little girl playing. The engineer reversed his engine, tooted down brakes, called out the brakemen, but all to no purpose—the momentum was too great and the train rapidly approached the little child, innocent of any danger, playing on the track. Relating the circumstance himself, the engineer later said: "Well, boys, I don' 'no why I dun it, but I dun it; jest before the train reached that girl I had a chance to ditch 'er and I ditched 'er—an' I saved the life of the little girl, but I killed 400 passengers. I got fired, of course, but what cu'd I do? Had to do something."

The government is trying to do something, just now, to save a situation and also to prove that the Sherman law is a good law—"reasonable" law, as it is interpreted and applied, upon occasion, by the government.

What is the situation, anyway? How came it about? Who is responsible for it? Who is its father and its mother? Who is there who will now step forward and say that he or his co-politicians were responsible for either the Sherman law or the situation now forced upon the country by the government? Let us think a moment.

If memory serves, back in the term of McKinley the diplomatic, who was succeeded by Roosevelt, the fighter, who was succeeded by Roosevelt, the honest endeavorer, who was succeeded by William H. Taft, a smiling gentleman trying to wear the coat made by Roosevelt—back, as we said, to the time of McKinley, must we turn to trace the lineage of the trusts, all the while not only fostered and guarded but encouraged under the Sherman law—all the while up to the near-end of the reign of Roosevelt.

Just what happened then it is difficult to remember. Some said the trusts were not playing fair. Some said that Charles W. Morse with his little hatchet cut down too many young financial cherry trees and—wouldn't stop; and others gave other reasons for the beginning of the revulsion of feeling against the corporations and the trusts. As near as can be judged, however, early in 1907 some one in the department "of justice" at Washington, time hanging heavily on his hands, re-read the Sherman law, or, reading it for the first time, in its entirety, suddenly paused and said, "Well, strange I never noticed that before; here we have built up the trusts under this law until they say they are too big, and right here is a clause whereby we can put 'em out of business under the same law. We can get 'em coming and going, sure as preaching." And just as sure as preaching the government, after getting them to coming, started in right there to get them agoing.

It would be very interesting to know precisely what Theodore Roosevelt said to William H. Taft about the trusts when he handed him his club and toga. Seems as if Taft didn't quite understand what was meant for him to do. Roosevelt has spoken up of late and said that he would not do it quite the way Taft is doing is—doing the trusts—and this we believe.

But it is a very serious question—the one question of greatest importance, industrially speaking, that has ever been

asked the voter, who also is the worker and the investor, "What shall we do with the trusts?"

An intelligent and fairly accurate attempt to answer this question involves too much to be considered properly in one article. It involves consideration of such subjects, all pertinent, as: "the natural trend of all properly conducted business"; scientific management; of "elimination of waste, which is the mainspring of scientific management"; of "disintegration"; of "reorganization"; of "corporation registration under the government"; of "government charters for all newly formed corporations"; of "government regulation and control"; and directly or indirectly of "government ownership" or control of the corporations it charters, or may later create. A full discussion also involves the question of proper and just treatment of labor by capital; the elimination of waste from the ranks of labor for its own benefit, and its reorganization, capitalization and centralization, also for its own benefit, under proper and uniform state laws or under a general federal law, to the end that labor will make its leaders amenable to law and that it may receive a fair and just return for its efforts; and the question of what we must do with the trusts also involves that psychological question of the unreliability and the meanness of human nature under prosperous conditions. Is it any wonder, then, that President Taft is trying to do something? There is much to be done—and election is coming next fall.

An experience of over twenty years in figuring for the general public, mainly for the corporations, always for capital either running smoothly or in the throes of trouble, always with the question before me, "How can we earn more money on our capital?"—always handling this question scientifically with the use of the detective "percentage" to indicate how the expense accounts may be cut down, has led, unconsciously, to a somewhat careful consideration of this mighty question which has so suddenly arisen, like some monster awakened from a long and troubled sleep to the din of the stone-age men planning to destroy it. And, strange to say, the government has gotten right down to first principles in its methods of warfare against the trusts, and some of its methods are like those of the stone-age men killing off an ugly old dynosaurus; just bang him over the head until he is unconscious, then bring him to and turn him loose in another pen, no matter how many of our "yung-uns" we may kill doing it. "Just hit 'im!"

Briefly, I will touch on some of these subjects as I have observed them and believe they must be handled.

The natural trend of all business, properly, prudently and wisely managed, is towards consolidation, concentration and the elimination of waste. The very spirit of business requires it and the exigencies of business demand it. Water does not run up hill unless forced up hill, nor does it stand still without becoming stagnant. Hence, all business must, if it succeeds, progress and proceed along the lines above indicated. It is the unwritten law of the nature of business that it will proceed along lines of least resistance most quickly, but also that it will move along lines of greatest resistance when profits invite it; not because of resistance, but in spite of it. Hence, then, combinations must and will follow. Corporations and combinations, obeying fundamental business laws, have become naturally and properly the order of the day, and then came the trust, born of the corporations.

Always, into every successful business, has arisen the question of how to eliminate waste; if not all of it, then how much of it? In the formation and in the conduct of the corporation there has not yet, apparently, been considered that most important question of all questions, "How can be eliminated that most wasteful thing on earth"—that individual who, when considering how he could organize a corporation to father and exploit his ideas or his struggling business, that person who, carefully, and oftentimes with borrowed pencil, first of all determines precisely what will be 51 per cent of the capital stock in his new corporation, and who, when he gets his charter, or often before he gets it, has stock certificates printed and causes to be issued to himself 51 per cent of the capital of the corporation, which he places in his vest pocket, and then proceeds to sell 49 per cent to the honest investor to obtain capital enough to conduct the business. Too often has it also been true that when the stock sold well, the legitimate purposes of the corporation have been abandoned for the illegitimate purpose of only selling stock for which large commissions are paid and large salaries are received—by whom? Why, the holder of the 51 per cent, of course. Is there any shame in this situation? No, not a particle, as these matters are regarded today. The only question of vital importance in hundreds, yea, in tens of thousands of corporations, the only question seriously considered is, "How can we get by?"

The trusts have absorbed the corporations. They are said to "operate in restraint of trade." That is, they want and scheme to get and to control all the trade there is, all the output of their particular line of industry. Corporations, we are told, have no souls. Having no soul, the trust is unable to discriminate between the desire for more than it needs and the just requirements of their chiefest, and, in the end, their only asset, the worker, for money, sometimes, is a poor asset. It all depends upon how it is gotten. "A good name is rather to be chosen than great riches."

Not being able to control its desire for more money, which it does not need, not being able, having no time, to recognize or to heed the just demands of labor, how, we may ask, in what manner, may the trust be compelled to do the square thing—how can it be compelled to divide properly with labor? Here they are, all organized, doing business at a "lickerty-split" rate, piling up under scientific management more and more profits in the vest pocket of the owner of the 51 per cent.

The 49 per cent men get mighty little, in comparison to what the 51 per cent man has gotten, first and last. But what the 49 per cent man has, he has paid for, he owns it, and his investment, honestly made in hard-earned dollars, is a sacred thing to him.

Along comes a statesman-politician and says, "Well, we'll smash the trusts. We'll show 'em just what we can do, and we will do it," and they proceed to do it. Who is now really hurt in this process of trust-busting? Probably the 51 per cent man has sold his holdings and the entire capitalization is now owned by the innocent investor who has placed therein his hard-earned dollars. Uncle Sam continues to "bust the trusts." The 51 per cent man, his money all in his pocket, sits tight, smilingly waiting until all the component parts have been scattered, waits until the omelet is thoroughly unscrambled, and then coolly buys back at a low price the offerings of the frightened investor who once placed his hard-earned dollars in the proposition. Who, in the name of sweet Heaven, has been benefited by this operation but the 51 per cent man? This trust-smashing of the government is more cruel than the cruelty any feudal over-lord ever practiced on his dependent vassals.

The government, if it must do something, and it must, might properly supplement the Sherman law and, with a commission, should compel every corporation now in existence to step up with its balance sheet and have its assets and its liabilities examined and carefully recorded, with special reference to the exploits of the 51 per cent man, and how he converted his 51 per cent into dollars. This should be compulsory.

The government should pass a national incorporation act compelling all new corporations to take a government charter, which should be granted only after it has examined the assets of the proposed corporation and has proven that every

dollar of its fair equivalent is invested in amount equalizing, at least, the capitalization to be issued or the total liabilities.

The government has already taken a long step in the right direction by passing the federal act of August 5, 1909, taxing the income of all corporations earning in excess of $5,000 net, in profits, and compelling sworn statements to be made annually by corporation officials. These sworn returns should also be made public records, available to the public just as a mortgage on realty is made a public record.

The government should say to labor, go and incorporate under proper state laws or under proper federal laws so that your organizations and your officers may be amenable to the laws of the land just as are the officers and property of business corporations.

Having, now, the corporations or trusts controlled by the government by charter, by inspection and by direction, let the government say to the laborer, "You must take one share, at least, in the stock of the corporation you work for. If you cannot pay for it at once, then you must pay for it in weekly installments. But a partner, a co-operator, a co-profit-sharer you must become, in the particular business in which you earn your living and in which you ought to have a direct interest." "But," says the 51 per cent man, "I won't invest my money in any such enterprise."

And suppose Uncle Sam should say to him, "Oh, very well, I am looking after this business, I know what it will earn, what it owns, how its property is invested and what it is worth, and I will loan on its bonds to the extent of 50 or 60 per cent of its capitalization." Who, then, may we ask, holds "the butt end of the stick?" Who, then, are the owners of the equity in that business and how are they protected? Think it over.

Scientific management must go on until there has been eliminated the 51 per cent man and the professional politician from the financial body politic. More honey-gatherers are needed—a smaller number of drones are desired.

Capital needs only a fair return on its investment; but, more than all, it needs protection from unwarranted attacks not only from within a corporate form it may be working under but without that form, whether the attack comes from the government or from labor.

Labor must eliminate the false prophet, the false leader and the grafter from its ranks, and it has already set itself about doing so. Labor needs an honest business manager, able at least to determine how much it has contributed of its vitality and its energy in exchange for a slight increase of wages, under the scientific management of the trusts; and such a manager as can compel a fair division of the extra profits under scientific management, which labor has never yet received, if the illuminating articles on "The Gospel of Efficiency" and scientific management are correct statements. Being made by a representative of the trusts, they must be assumed to be correct, as far as they go into details.

The "common people" need—yea, are about to receive—fair and proper treatment, and within the term common people are included all the honest workers and investors.

The grafter, whether he graft on labor, the municipality or the commonwealth—and the tax-dodger is one of them—must go. Only in foreign countries do they know how to handle graft—their way. There they lift the grafter up, place him on a throne, crown him, and then, he being of divine origin, they bow down and worship him. In this country we are eliminating waste as a correct and scientific business principle, hence we are pursuing the grafter, and we will get him yet.

Right now the question looms up, "Who is that man who, having received the nomination for the presidency, can most wisely, firmly and tenaciously deal with questions herein briefly touched upon?" They are all vital, they all affect the masses, and they must be settled or regulated soon. And they will be dealt with to the advantage of the masses, directly.

Very soon things will begin to loosen up, "politicianally" speaking. There are signs of an early spring in politics. Just now, however, everything is as calm and serene as a "peace society banquet"—with the genuine peacemaker absent.

The work of remodeling the Baltimore & Ohio passenger station Newark, O., will be started within a week or two.

The Canadian Northern has filed with the Railroad Commission plans for the constructon of a second viaduct over the end of Main St., close to Norwood bridge and between the new viaduct at the foot of Bell Ave. and the bridge, at Winnipeg, Man.

Bids will be received until noon, April 15, by the Canadian Pacific at Calgary, Alta., for design, manufacture and erection complete of the following steel highway Bridges: Two 125-ft. bridges; 4 100-ft bridges; 14 75-ft. bridges and 9 60-ft. bridges.

The Canadian Pacific has awarded the contract for extending piers and abutments of the Red River bridge at Winnipeg, Man., to the Foundation Co., Ltd., of Montreal and Winnipeg, Can.

Plans are being prepared at the office of the American Bridge Co., New York City, for the construction of 14 steel bridges which the Delaware & Hudson is to build this year between Oneonta and Rouses Point. The bridges range in length from 95 ft. to 180 ft. each and will be for the most part of the through riveted span type. Work is going on upon a new bridge for the Delaware and Hudson over the Mohawk at Schenectady. Operations were begun last August and to date two abutments and two piers have been completed; one pier is nearly done, and the fourth will be finished in about a week. Concrete is the material used for this work.

It is stated that the Delaware, Lackawanna & Western has received bids and will let contracts at once to put up the new passenger station at Montclair, N. J.

The Grand Trunk is building a bridge at Bay City Mich. The plans call for two draw spans of 250 ft. each, and five fixed spans of 150 ft. each, with concrete piers. This company is building a bridge over the Lachine canal at Wellington street, Montreal, Que. This company is building a bridge over the entrance to the harbor at Portland, Me., to replace the present structure, to have a 225-ft. draw with concrete piers.

It is reported that the Great Northern will start work in the spring on the construction of two stations, one at Helena and the other at Butte. Plans for the structures have been completed and the cost is estimated at about $175,000 each.

The Manufacturers' Railway of St. Louis expects to begin work soon on a ten-story freight depot and warehouse to cost approximately $750,000. The warehouse will be used by some of the trunk line railways jointly with the Manufacturers' Railway.

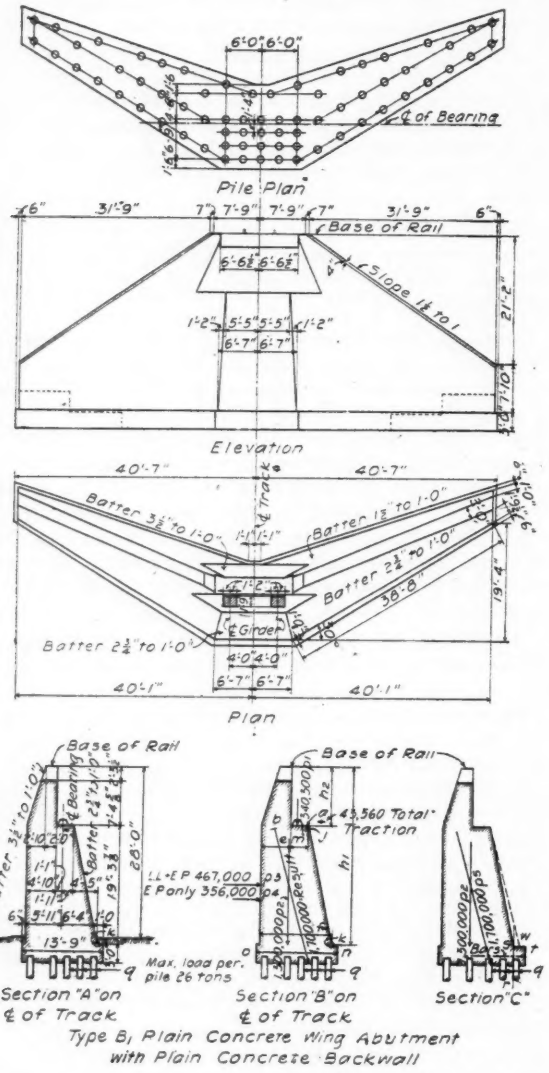
The St. Louis & San Francisco is having plans prepared for a new passenger station to be erected at Springfield, Mo. The station wil cost $250,000.

The Southern will make arrangements for the construction of a steel bridge to replace the present wooden structure at the foot of West Elmwood Ave., Columbia, S. C. Portland, Ore., which will be 200 ft. x 50 ft.

Concrete Practice*

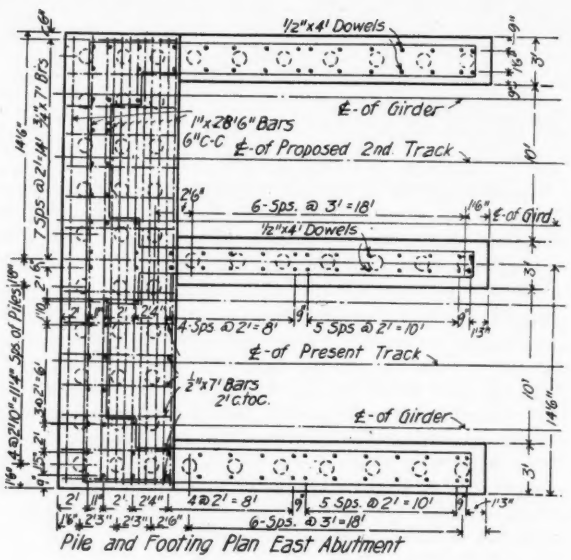
Typical and Standard Structures of the Chicago Milwaukee & St. Paul Ry.

The Chicago, Milwaukee & St. Paul has been one of the most energetic and progressive railways in adopting concrete for railway structures. The drawings af this company contain a number of standard reinforced concrete structure designs, probably more than any other American railway. Comprising the latter class are the following: abutments, piers, arches, culverts, bridge floors, trestles, manholes, and turntable pits. Plain concrete has been adopted as standard for the following: abutments, arches, piers, turntable pits. Reinforced concrete construction has been used, but not adopted as standard, for the following types of structures: coal stations, freight and passenger depots, ducts, right of way fences, foundations, oil houses, pattern shops, fence posts, reservoirs, retaining walls, roundhouses, blacksmith shops, grain tanks and tunnel linings. Plain concrete has been used but not adopted as standard for the following: freight and passenger depots, foundations, freight, passenger and shipping platforms, and retaining walls.



Type B, Plain Concrete Wing Abutment with Plain Concrete Backwall

In describing the practice of the railway, C. F. Loweth, chief engineer, says "Practically all our masonry is concrete, and most of it is reinforced concrete. While we have standard drawings for a variety of concrete structures, this does not imply that they are invariably used, other types being adopted, depending on location and other governing circumstances."



Double Track "U" Abutment, C. M. & St. P. Ry.

Plain Concrete Wing Abutment.

The wing abutment shown herewith is usually made of a 1:3:6 mixture, with crushed stone; the mixture used, however, depends on local conditions. The back of the abutment is vertical and the batter of the face is varied to suit conditions. Back walls are either plain or reinforced concrete, this drawing showing the reinforced type. The forces assumed for the design are: dead load, 1-3 of the vertical pressure, weight of earth, 100 lbs. per cu. ft.; live load, Cooper's concentrated loading, or a distributed load of 12,000 lbs. per lineal foot of track, distributed over an eight foot rail section, spreading 6 inches per vertical foot in earth, or 12 inches per vertical foot in concrete. No impact allowance is used in the design. The abutment and wings are built monolithic. The ridge seat is made of such width that base castings are at no point nearer to edge than 12 inches. Footings are 2 to 3 feet thick and should be from 3 to 5 feet below ground level depending upon latitude. Pile footings are generally 3 feet thick with piles projecting 1 foot into concrete. Piles spaced at least 2 ft. 6 ins. one way and 2 ft. the other.

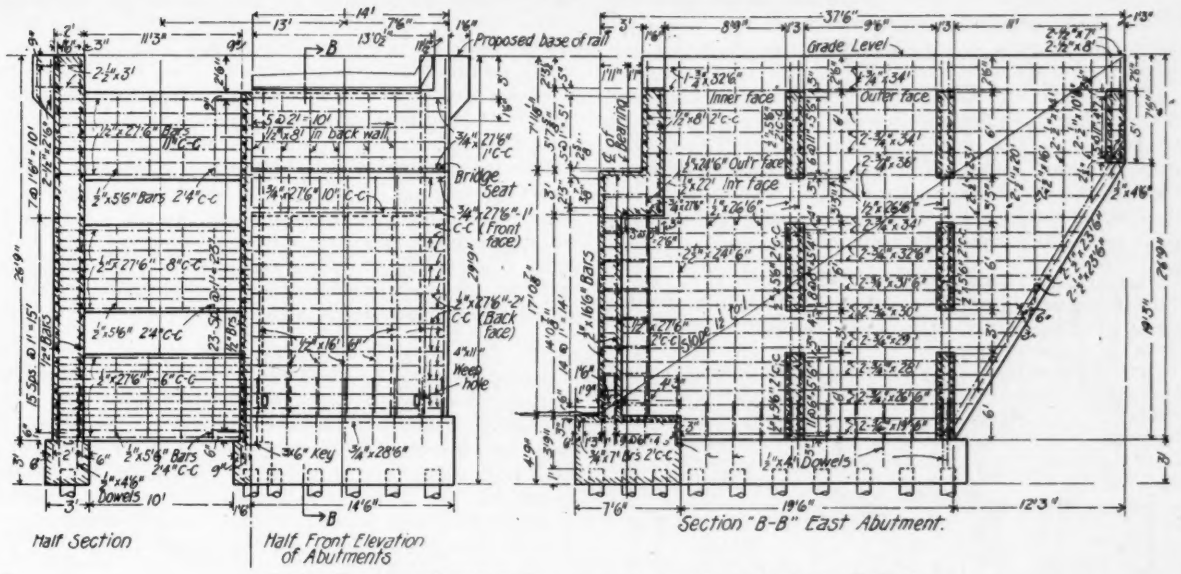
Reinforced Concrete Arch Abutment.

The mixture used in reinforced concrete arch abutments is 1:2½:5, the choice of aggregate being determined by local conditions. The backwall is of reinforced concrete.

High carbon steel, deformed reinforcing bars are used The 1-in. bars lap 3 ft. 6 ins., the ¾-in. bars lap 2 ft. 6 ins., and the ½-in. bars lap 2 ft. The allowable unit stresses are: steel, 13,500 lbs. per sq. in.; concrete, 750 lbs. per sq. in. The bridge seat is formed by a horizontal offset from the front wall. The pressures assumed for design are the same as in plain concrete wing abutments above.

Footings are built in one continuous run; no vertical joints are allowed in neatwork. Horizontal joints are only permissible where shown on plans. There are two weep holes (circular) in the abutment face. The footing is stepped up towards the back of the abutment, where the pressure decreases. The fillet in the lower left hand corner of the arch is to obtain the same thickness of concrete at point where the footing is stepped up 2 feet. The bridge seat is heavy

*The first of a series of articles on this subject.



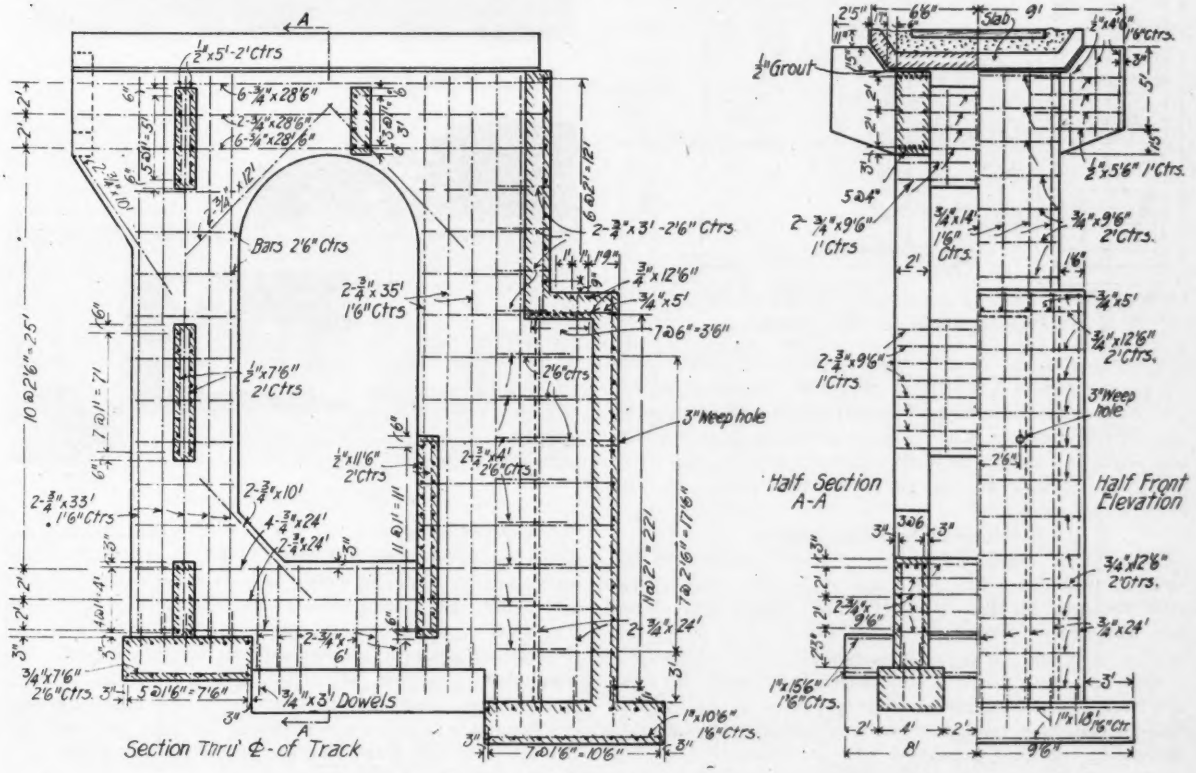
Double Track Reinforced Concrete "U" Abutment, C. M. & St. P. Ry.

and is supported by heavy posts. The side walls are tied together by 5 reinforced struts, which must counteract the lateral earth pressure. To retain the ballast at the back of the walls, projections 3 ft. x 1-ft 6-ins are provided, perpendicular to the wall.

Reinforced Concrete "U" Abutments.

The mixture used in reinforced concrete "U" abutments is 1:2½:5, reinforced with high carbon steel, deformed bars. The stresses allowable in design are: steel 13,500 lbs. per sq. in.; concrete 750 lbs. per sq. in. The bridge seat is formed by an horizontal offset from the face wall. The pressures assumed for design are: dead load 1-3 of the vertical pressure, earth at 100 lbs. per cu. ft.; live load, Coopers concentrated loading, or a distributed load of 12,000 lbs. per lineal foot of track distributed over an 8 foot rail section, spreading 6 inches per vertical foot in earth, and 12 inches per vertical foot in concrete. No impact allowance.

The footings have no horizontal joints. Vertical joints are allowable in footings, parallel to track, but each section must be brought to top in one run. No vertical joints are permissible in abutments. Horizontal joints in neatwork are permissible only through the middle of the tie wall.

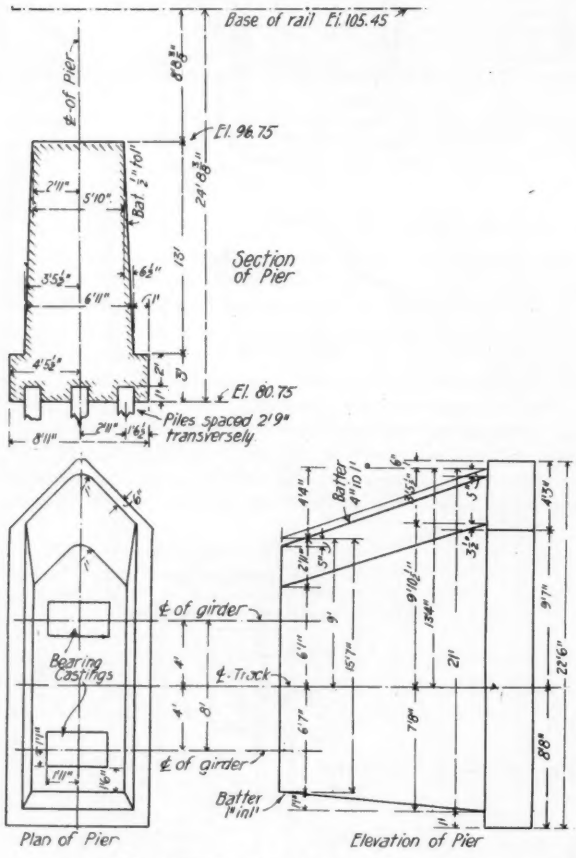


Reinforced Concrete Arch Abutment.

All steel is placed 3 inches from face unless otherwise noted. The footings are made with keys, and dowels are imbedded to form a strong joint. Four weep holes are provided in the abutment face. Seven reinforced struts are used to tie the side walls together, resisting the horizontal earth pressure. Projections 1 ft. 6 ins. thick and 3 ft. long are provided at the ends of the side walls perpendicular to track, to retain ballast. The wall is cut back at an angle, and extends 11 ft. beyond the footing. This balances the load on the footing. The bridge seat is supported by heavy posts on the sides and in the center.

Plain Concrete Piers.

Plain concrete piers are made of a 1:3:6 mixture, with a batter of ½-in. to 1-ft. The forces assumed in design are:



Plain Concrete Pier, C. M. & St. P. Ry.

live load on bridge, dead load of bridge and masonry, earth on footing offsets if it is 5 ft. or more in depth, wind, ice, and also current, if swift. The starkwater continues up to the top of the pier, with a slope of 4 ins. to 1 ft. The top width is made 2 ft. wider than the pier casting to be used. If footings are on piles they are designed as for plain abutments.

Reinforced Concrete Trestles.

The use of concrete piles in concrete trestles is just being introduced. The piles are made in a yard. The reinforcement consists of longitudinal high carbon steel bars and hoops. The bars are deformed. The unit stress in the steel and concrete is nominal.

Plain concrete piers, 1:3:6 mixture, are used for very low trestles, but reinforced piers are used in most cases. The mixture for reinforced piers is 1:2½:5, the aggregate depending on local conditions. Loose deformed bars, high carbon steel, are used for reinforcement. Unit stress in steel is 13,500 lbs. per sq. in.; in concrete 750 lbs. per sq. in.

The footings of the trestle are made with a 3-in. x 6-in. key in order to give a good bond betwen the piers and abutments and the footings. Dowels 4 ft. 6 ins. long and ¾ in. thick are placed in the footings to strengthen the joint. A grid of horizontal bars is placed at the top of the concrete piers to take care of shear, as shown in the drawing.

Two weep holes are left in the abutments 3 ft. 8 ins. above the footings. The shape of the wings introduces a balancing pressure at the back of the footing. The wings are tied together by a strut 1 ft. 9 ins. wide and 6 ft. 4 ins. high. The construction notes are as follows: Footing slabs and piers, no joints; abutments—no vertical joints, horizontal joints permissible through middle of tie wall.

Trestle Floor Slab.

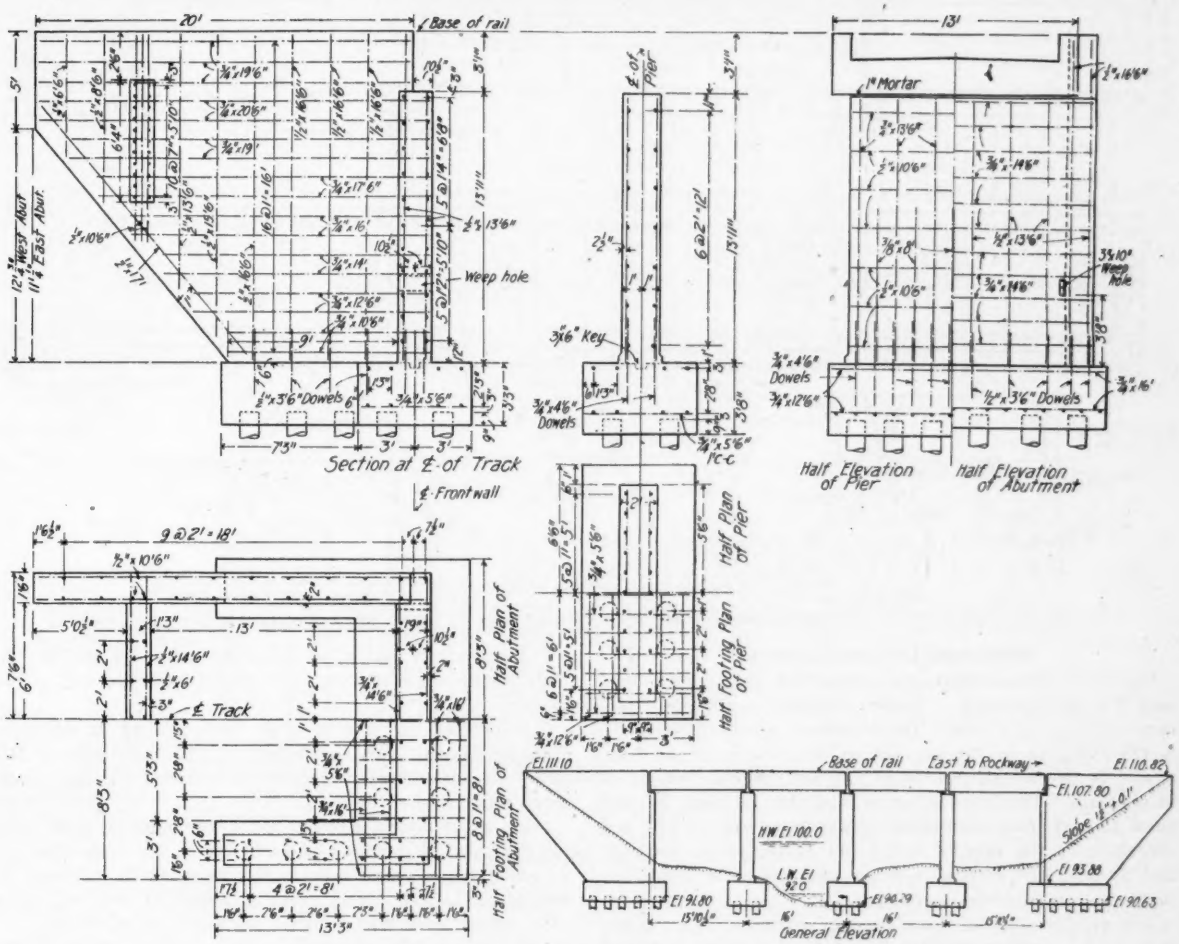
A mixture of 1:2:4 is used for slabs, and they are built in place, or near the site, or in the concrete yard. The reinforcement is of deformed high carbon steel, consisting of loose bars and stirrups. Forces assumed in the design are: dead load, weight of slab at 150 lbs. per sq. ft., and ballast at 125 lbs. per sq. ft., including track; live load, Cooper's E-50 and E-55, with 50 per cent allowance for impact.

For double track four slabs are required, two "M" or

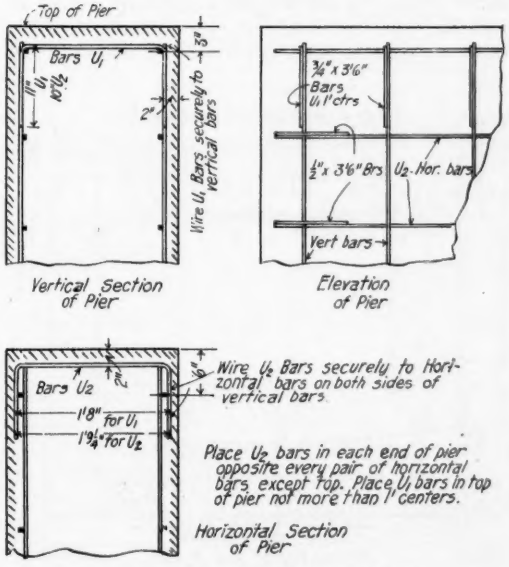
Girder Bridge with Concrete Slab Deck.

Reinforced Concrete Viaduct.

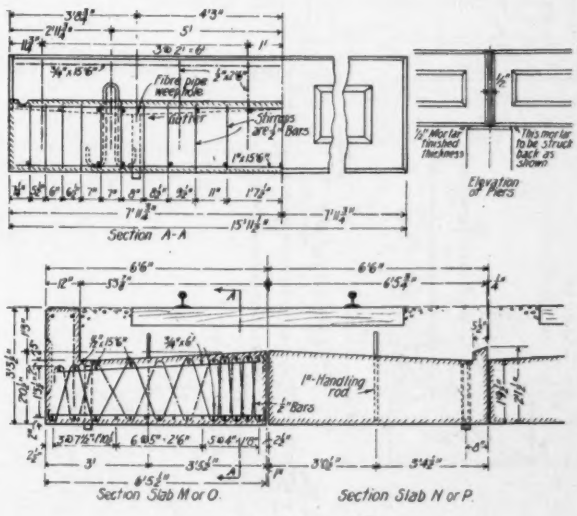
"O" parapet slabs, and two "N" or "P" center slabs. For single track two slabs "M" or "O" are required. A timber wall plate for retaining ballast is used, dowelled to the slab, where the track passes from a slab to an open floor bridge. The tops of piers beneath slabs are provided with a grid of reinforcing bars to prevent the concrete shearing off. The weight of a slab, type "M," is 16.5 tons, type "N" is 14.9 tons. The slabs are handled by derrick. A chain is passed through the drain holes, and a pin is passed through the end link. The concrete and drain pipe are protected during this handling, by wooden blocks, as shown.



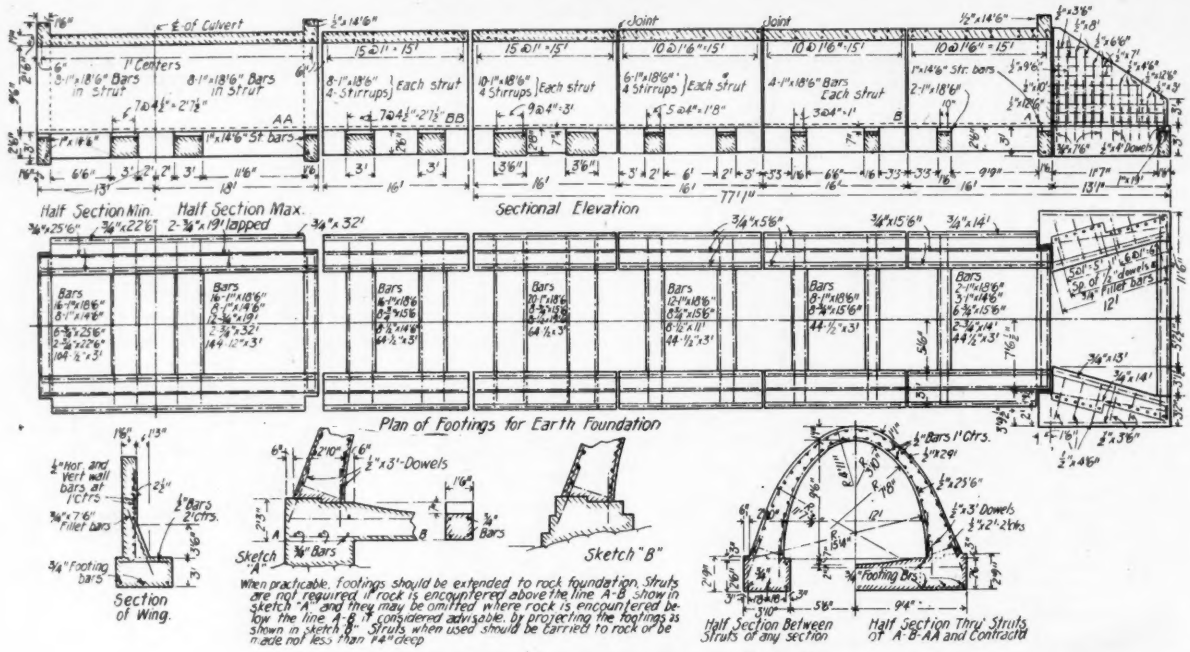
Reinforced Concrete Trestle, Abutment and Piers, C. M. & St. P. Ry.


Top of Pier
Bars U1
Wire U1 Bars securely to vertical bars
Vertical Section of Pier
Elevation of Pier
Vert bars
Bars U2
Wire U2 Bars securely to Horizontal bars on both sides of vertical bars.
Place U2 bars in each end of pier opposite every pair of horizontal bars except top. Place U1 bars in top of pier not more than 1' centers.
Horizontal Section of Pier

Reinforcement at Top of Concrete Pier.



Concrete Trestle Slab.


℄ of Culvert
Joint
Sectional Elevation
Half Section Min.
Half Section Max.
Plan of Footings for Earth Foundation
Section of Wing.
Sketch "A"
Sketch "B"
When practicable, footings should be extended to rock foundation. Struts are not required if rock is encountered above the line A-B shown in sketch "A" and they may be omitted where rock is encountered below the line A-B considered advisable. Or projecting the footings as shown in sketch "B". Struts, when used should be carried to rock or be made not less than 1'4" deep.
Half Section Between Struts of any section
Half Section Thru' Struts of A-B-AA and Contra'd

Reinforced Concrete Arch Culvert, C. M. & St. P. Ry.

Reinforced Concrete Culverts.

Reinforced arch culverts have deformed, high carbon steel bars for reinforcement. Under ordinary conditions there is no stress in the steel. The maximum compressive stress in the concrete is 500 lbs. per sq. in. The dead load assumed is 100 lbs. per cu. ft. of fill, and 150 lbs. per cu. ft. of concrete. The live load used in design is 12,000 lbs. per lineal foot of track distributed over 8 ft. at base of rail, and spreading at the rate of 6 ins. per vertical foot in earth, and 12 ins. per vertical foot in concrete. An allowance of 50 per cent is made for impact.

The arch is made in three circular segments, upper radius 3 ft. 10 ins., intermediate radius 7 ft. 8 ins., lower radius 15 ft. 4 ins. The construction joint between the footing and arch proper is made with a step, which introduces a shearing resistance against forces tending to spread the arch at the bottom. Dowel pins are placed at this joint also. At the wing walls, the arch section is reduced near the bottom to make a vertical joint with the abutment.

General notes for standard arch culverts:

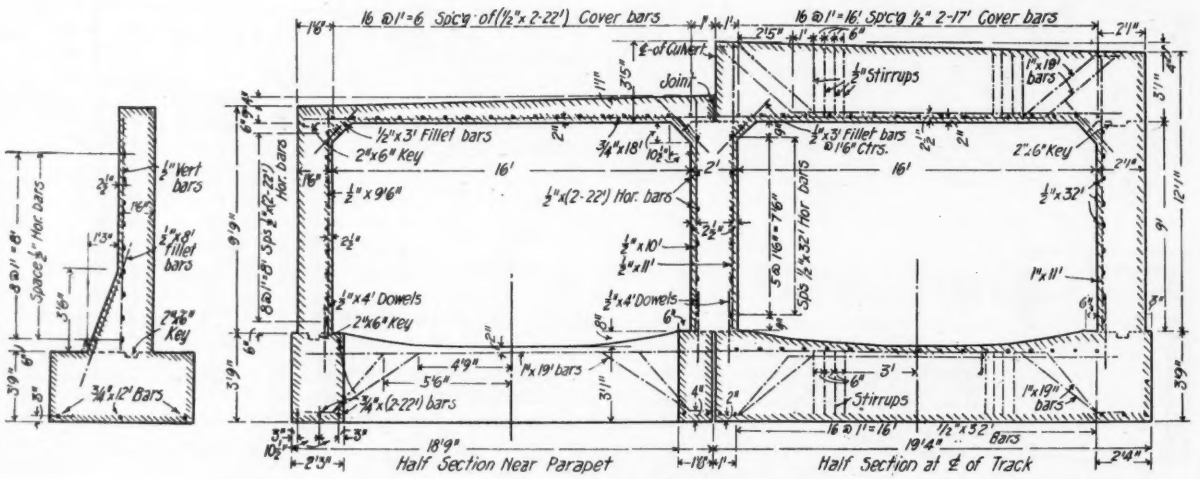
"The sections detailed on this sheet are to be used in culverts under fills less than 40 ft. high (above the top of the footing).

"In general, no section shall be less than 12 or more than 24 ft. long. When owing to grade or skew of culvert the length of the two center sections exceeds 24 ft. each, three sections shall be used.

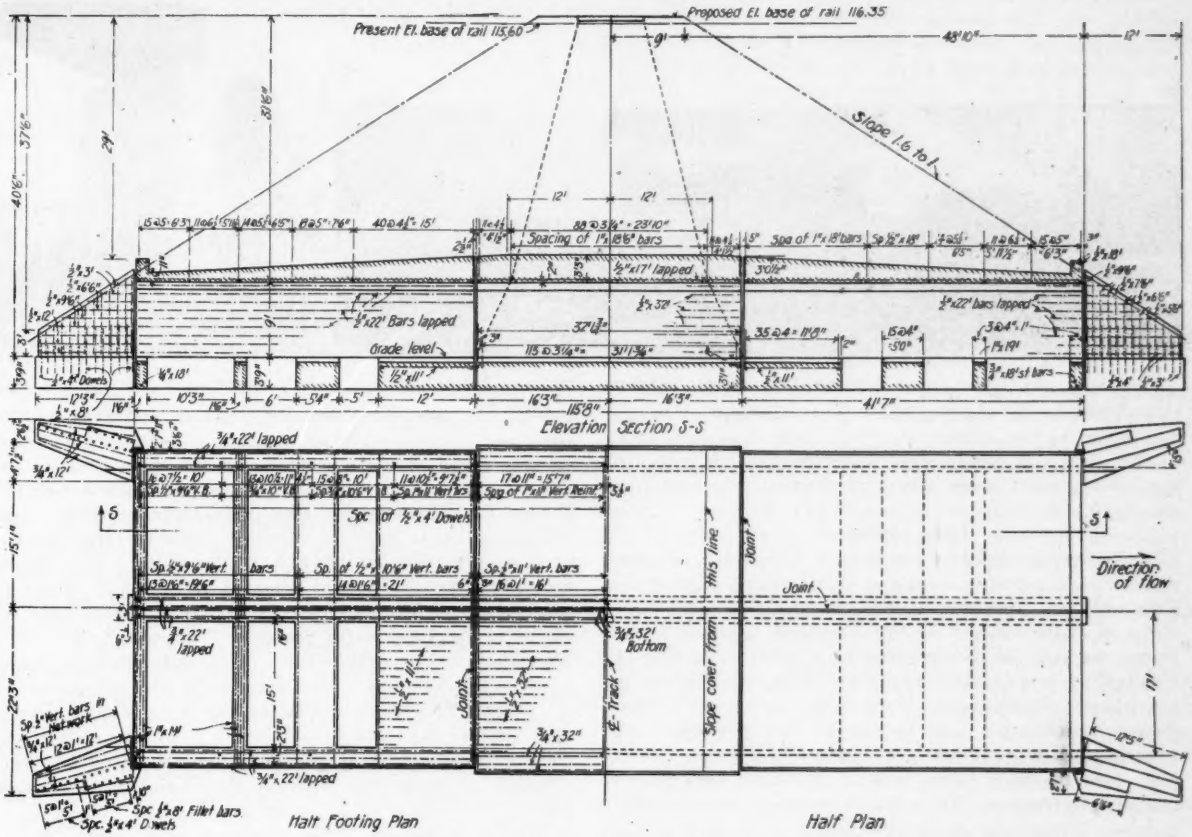
"For a culvert on a steep grade or skew or both, vary the length of all sections on each side of the center line approximately in proportion to the increase or decrease in length of the half barrel over the length of the half barrel of a square level culvert under the same height of fill.

"In view of the desirability of a steeper grade in the upstream half of the culvert, no allowance should be made for probable settlement near the center of the fill, except in cases where the grade is so nearly level that there is a possibility of the formation of a pocket.

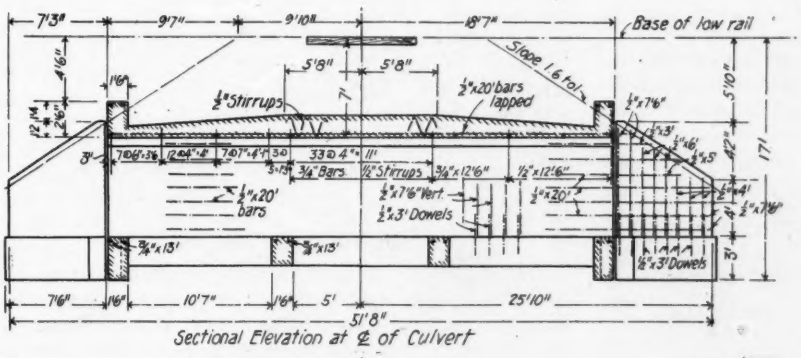
"The invert should be paved with a concrete slab in all spaces between struts so as to form a continuous concrete invert. Where excessive settlement is to be expected, the

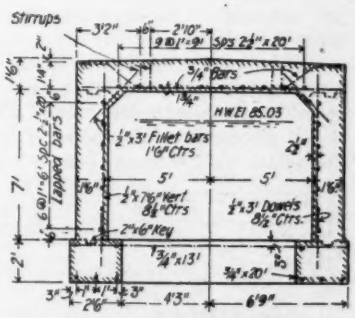


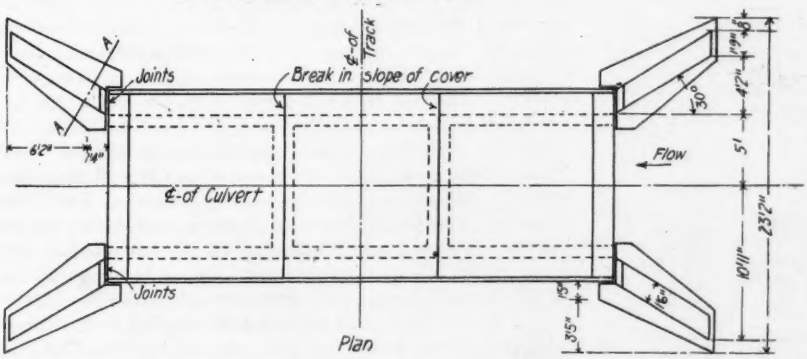
Double Box Culvert, Section Parallel to Track.

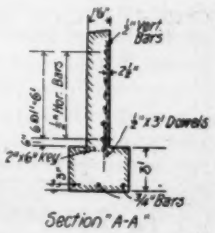


Double Box Culvert, G. M. & St. P. Ry.

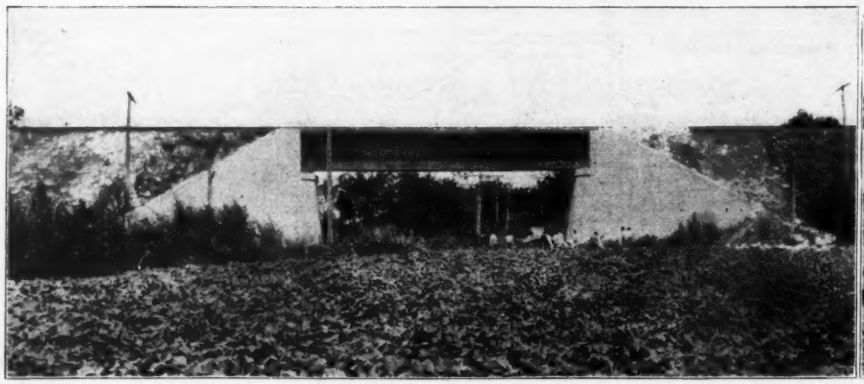




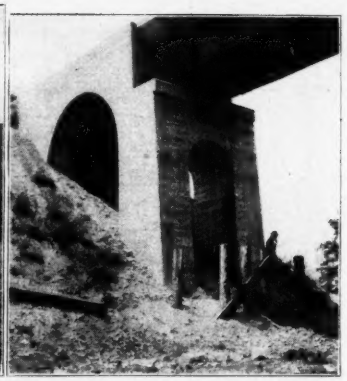




Single Box Culvert.



Concrete Deck Girder Viaduct.



Arch Abutment, C. M. & St. P. Ry.

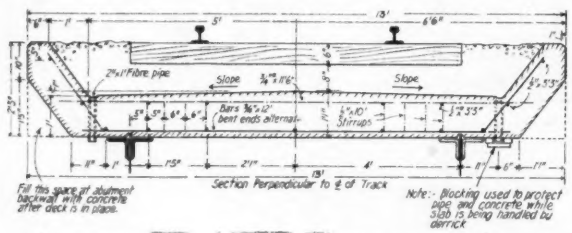
slab should be put in below the top of the struts an amount approximating the settlement to be expected, or the placing of the slabs may be deferred until settlement is complete, due precautions being taken to prevent scouring until slab is placed."

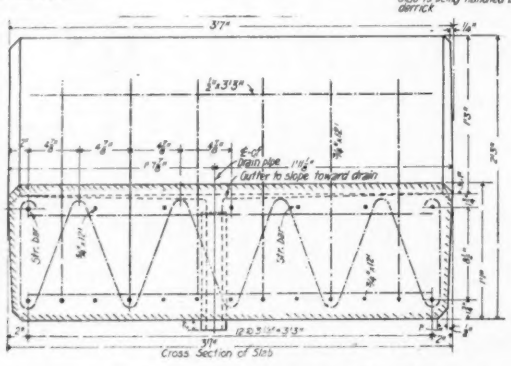
Box Culverts.

Single track reinforced concrete box culverts are made monolithic, except for expansion joints. High carbon steel deformed bars are used as reinforcement, designed for a stress of 13,500 lbs. per sq. in. The loads assumed for the design are same as in reinforced arch culverts above. The longitudinal cross section at center line of track shows the construction joints, each of which has a key to increase the mechanical bond in the structure. Dowels are also used to strengthen these joints. The lateral cross section and the plan show the open joints between the wing walls and the rest of the structure. These joints are right angled, and no provision is made for a mechanical bond. The floor is made thicker in the center, tapering toward the parapets. The lower face of the slab is level.

The top of parapet wall in this design is level with the top of tie, which makes it somewhat difficult to remove ties from the track.

Double track reinforced concrete box culvert footings are made in two sections, with a joint in the center, as shown in section, longitudinal to track. The cover also has a joint at this place. The joint, however, is not carried up through the center wall between barrels. The shape of the joints


Slope
Slope
Bars
Stirrups
Fill this space at abutment backwall with concrete after deck is in place.
Section Perpendicular to ℄ of Track
Note: Blocking used to protect pipe and concrete while slab is being handled by derrick



Single Track Concrete Deck for Plate Girders.

between the end walls and the footings, and between the cover and the end walls, is the same as in the single track culvert; dowel pins are used also in the same manner. In the single track culvert the slab is in one section. In the double track culvert the slab is in three sections. The middle section is made of sufficient width to carry the entire pressure from the track, i. e., the width of the slab is determined by the line of pressure distribution, shown in the elevation. The two outer slabs are therefore only required to carry the earth pressure. The center slab has a uniform thickness, and thickness of the outer slabs decreases towards the parapets. The wing walls are not joined to the body. The cross section of the wing walls shows a fillet between wall and footing which is to take care of the earth pressure where the ordinary section would be overstressed. A good joint between the footing and the wing wall is obtained by a key in concrete and by dowels.

The center portion of the bottom is solid, while the end portions are built with struts. The side walls of the center section are heavier than the side walls of the end section on account of longitudinal live load pressure, but the center wall has the same thickness throughout. The construction notes for both single and double track box culverts are as follows: Footings—Joints, except where shown, must be parallel to track. Each section to be brought to top in one continuous run. Walls—No horizontal joints. Cover—Vertical joints permissible parallel to track only. No horizontal joints. Foundation may be altered by engineer in charge. Every bar is to be a deformed bar with effective section equivalent to that of a square with side equal to size given.

Concrete Girder Slab Floor.

Unit slab floors are used on steel through and deck girders. The mixture used is 1:2½:5, reinforced with high carbon steel, deformed bars. Unit stress in steel 13,500 lbs. per sq. in.; in concrete 750 lbs. per sq. in. The slabs are preferably built on the girders; when this is impossible, the slabs are made in the yard and shipped to location. Slabs are placed by derrick. No waterproofing is used. The slabs, however, slope in both directions from the center line of track; an outlet for water is provided by 2-in. fibre pipes, extending vertically through the slabs. A layer of stone ballast about 1 ft. 3 ins. deep is used on top of the slabs, retained by concrete parapets. The following forces are assumed for design: Dead load, concrete, 150 lbs. per cu. ft.; ballast, including track, 125 lbs. per cu. ft.; live load Cooper's E-50 or E-55; impact 50 per cent. The slabs are picked up by the derrick, using hooks embedded when slab is made.

The slab is made with parapet walls sloping at 45 degrees. The reinforcing bars are made with one bend. The rods are alternated, the bend on one side of the slab being on every other bar. The reinforcing bar lies near the inner face of the sloping parapet.

For multiple spans, or for double spans on a skew or on a curve, special rectangular or trapezoidal sections may be used.

Construction Notes.

If deck is built alongside to be lifted into place, build forms continuous in as great a length as the character of the ground allows and construct deck in alternate 3-ft. 7-in. sections.

If deck is to be built in place on the girders in their final position it shall be constructed in alternate standard 3-ft. 7-in. sections.

If the deck is to be in place on the girders before they are in their final position, build the end sections alongside and place them on girders and back wall after the bridge is in place.

We are indebted to Mr. C. F. Loweth, chief engineer of the Chicago, Milwaukee & St. Paul Ry., for the diagrams and plans in this article, and to J. H. Prior, assistant engineer, for the data and illustrations.

WORK OF RAILWAY TESTING DEPARTMENT.*

By E. P. Tilt, Engineer Tests, C. P. Ry.

Up to the year 1875 there had been constructed in America about 75,000 miles of railway, and this was the year just preceding the introduction of the automatic air brake, when we find the Pennsylvania Railroad establishing what we believe to be the first railway chemical laboratory in America. The man selected to be the head of this department was the late Dr. Charles B. Dudley, who became a world wide known authority on railway materials. His own words written some time after taking the position in November, 1875, show how he, a college trained chemist, and his department were regarded: "So little was the possible use of a chemist appreciated, and so little work was known that he could do, that permission to have a chemist was granted more as a concession and as an experiment than with any faith or belief that the scheme would prove to be permanent or valuable. It is also fair to say that at that time the field for work was as much unknown to the chemist himself as to the railroad officers." Consider the conditions at this time: railways were expanding very fast, much material had to be purchased and the standards of quality desired had largely to be investigated and determined, and suitable specifications drawn up to cover the purchase of these materials. The laboratory staff then consisted of Mr. Dudley and one or two untrained helpers and this grew until today there is a force of over thirty chemists and other assistants, in addition to a staff of about 200 inspectors of various kinds. The laboratories of the Pennsylvania Railroad report that in 1910 there were 35,872 samples of various materials examined in the chemical laboratories on which there were made 121,970 determinations. In the physical testing laboratory 58,193 routine tests were made which included the inspection of the following material: The inspection of 97,759,972 lbs. of bar iron, of which 4,007,049 lbs. were rejected; 840,750 pieces of air brake hose, of which 108,300 were rejected; 3,000,480 lbs. of waste, of which 1,008,275 lbs. were rejected; 33,734,552 lbs. of steel castings, of which 1,161,379 lbs. were rejected; the inspection of 211,453 wheels, of which 2,519 were rejected. We have given these figures as representing the work done by the largest railway testing department that we know of and the figures well serve to give some idea of the quantity of materials required by a big railway, and the rejections prove the necessity of inspection. There is not a trunk line in America today which has not its testing laboratory in greater or less degree and we find by inquiry and estimate that railways are spending from $10,000 to $150,000 per year on their testing departments. One railway informs us that as a result of an investigation made by their testing department they effect a yearly saving of $80,000 in the treatment of cross ties as compared with their previous practice, while the testing department on another road recently got a reduction of $1,500 on a single shipment of telegraph wire which was not up to specification.

The principal economies which are being effected by railway testing departments, outside of the economy which results from the use of good material instead of inferior material, are those relating to the purification of boiler waters, studies on fuel consumption, investigations in connection with rails, tyres, paints and rubber goods. Some testing departments supervise the manufacture of disinfectants, deodorizers, metal polish, fire extinguishers, boiler compound and cutting compound; and one railway company makes all of the freight car paint which it uses. As an indication of the amount of inspection and testing done we may say that there was formed in 1898 in Philadelphia the American Society for Testing Materials, and this has today a membership of about 1,400, made up of engineers of all kinds and the manufacturers of engineering materials, and a five days' session is held each year for the discussion of scientific papers and the drawing up and standardizing of specifications for materials. Next year the International Society for Testing Materials meets in New York, and the engineering professions from every manufacturing country in the world will probably be represented. It is very evident therefore that the testing of railway materials is now on what may be termed a standard practice basis and there is a wealth of literature dealing with the technique of inspection and the qualities desired in the materials used. The time is therefore long since past when the question of whether a railway testing laboratory is a necessity or not, and the fact of such a department existing in every progressive railway organization indicates that it is necessary and must therefore be a paying investment.

The management of the Canadian Pacific Railway had early recognized the value of a railway testing department, and since 1891, when W. Bell Dawson started the first laboratory, with Milton L. Hersey as assistant chemist, there has been a department of some magnitude, greater or less, depending upon what purchases of supplies were being made. Within the last few years there has been a division of the system into Western and Eastern lines, the former of which has had its own chemical laboratory at Winnipeg since 1905, which has specialized in water troubles with much success, in addition to doing the other routine work which comes to a railway chemical laboratory. The work on Eastern lines is done conjointly, by commercial testing companies who do all of the foreign mill inspection; Dr. Milton L. Hersey and associates, of Montreal, who do all of the chemical work; and the testing department with laboratory at Angus shops, who do a portion of the domestic mill inspection, and who take charge of the routine sampling and inspection of materials received at the Angus shops, where are located the locomotive and the car departments and the general stores. The duties of the Angus shops testing department include also the preparation of suitable specifications, the investigation of the failures of materials and the studies of processes or special materials. The testing of devices is handled by the mechanical engineers of the locomotive or the car departments.

In the purchase of materials of such wide variety and origin as are required for our company the question of economical inspection is important and the present organization has been found to be a satisfactory and cheap one. A great deal of our heavy materials are bought in Europe and the United States and the keeping of our own inspectors at these distant points would entail much expense. Otherwise we would inspect the material on receipt at the point where it is to be used, which is certain to be unsatisfactory if the material is not acceptable, and the equipment waiting for it would be held up. This foreign inspection has been well handled by outside inspection companies who work under our instructions and with our

*From a paper read before the Canadian Railway Club.

specifications, and who guard our interests, whether the material is offered at Sheffield, Essen or Pittsburgh.

Our chemical work is done by Dr. Milton L. Hersey and his associates, whose large staff enables them at any time to rush special work or to take care of any sudden increase in work. The staff, which includes among others, Dr. Milton L. Hersey, who has been chemist for the C. P. R. since the inception of a testing department, Robert Job, formerly chief chemist for the Reading Railroad, and later of the firm of Booth, Garrett & Blair, Philadelphia; Charles R. Hazen, former assistant chemist of the Lake Shore & Michigan Southern, are all available for consultation regarding any matter connected with the railway, and this places at the railway's disposal talent which would not otherwise be available in an ordinary railway organization. In doing all of the chemical work for the mechanical departments at Angus shops, Dr. Hersey is kept in touch with all of the inspection and testing, and in addition makes all the fuel analyses for the fuel department, makes investigations and reports of various kinds for the freight claims department and the express company; makes different analyses for the engineering department, examinations of foods and waters for the hotel and dining car department, and assays of ores and varied analyses for the industrial department. A large amount of good work is being done by the chemical department in the treatment of waters for locomotives and stationary boilers and in the selection of the proper boiler compound. This is one of the economies which is hard to show in exact figures, yet we believe that it is a matter of saving hundreds of dollars monthly, for the cost alone of a proprietary compound to replace our present standard boiler compound would be an increased expense to the company of $500 a month. One man is kept constantly on the road to see that the compound is properly used and to keep the chemical laboratory advised of conditions generally on the line.

The staff at Angus shops consists of an engineer of tests and an assistant, who pay particular attention to the special tests and investigations in connection with material, the consideration of specifications and the checking and reporting to the proper officials of the work done by the outside inspection companies. There is a chief wheel inspector, who has an assistant to inspect the daily output of our wheel foundry, and who has in addition charge of the stocks and of the mixtures for the cupolas of the wheel foundry and the grey iron foundry. He also inspects and reports on all failed cast iron wheels and makes special tests of new materials which are submitted for the use of the foundries. There is a laboratory assistant who has charge of all the physical testing and who is assisted by from six to ten of the best apprentices from the shops in the testing and inspection which is done at Angus. We are at present taking shop apprentices for a period of from four to six months, as assistants in the ordinary physical testing and the inspection of material. In this way our apprentices become familiar with the principal characteristics of the common metals and materials which they may meet in the shops, and thus we hope to make them more interested in their work and inculcate the idea that inferior material must always be looked out for. This gives us a large number of inspectors which can be drawn on as required to suit the varying demands. There are, of course, some disadvantages, one of which is that every new boy must be trained, and about the time that he becomes truly valuable he must be returned to the shops; but on the whole the system is working out very well.

The heavy materials are inspected at the mills, and this includes firebox and flange plates, structural shapes for cars, axles, tyres, automatic couplers, billets, springs and cast iron wheels.

Inspection and testing is done upon receipt at Angus of the following materials: bar iron and steel, chain, steel castings, rubber goods, wire cable, bronze and brass castings, babbitts, solders, waste, boiler tubes, brake beams, paints, oils, soaps, cleaners, fabrics, etc.

The inspection of rails and fastenings, bridges and structural material is at present done by outside companies directly for the engineering department, which gets the records of these tests.

Where locomotives or cars are to be built outside, the purchasing department advises us what portion of the inspection work we are required to take care of, and this is provided for, as well as seeing that the other inspection work is done, and the necessary reports made and checked. The inspection made during the building of locomotives outside is done by inspectors from our own locomotive shop who see as to the compliance with our drawings, pass judgment on the workmanship, fit and finish, and assist us in taking samples and following up the tests which indicate the quality of the materials used. Where cars are built outside, the inspection is made in part by men from our own car shops working in conjunction with an outside inspection company, and we are called on for such additional tests of materials as may be considered necessary. The outside construction companies are of course supplied with our specifications, and purchase materials in accordance with them and the materials are subject not only to inspection by the purchasing company but are often checked by ourselves.

The question of where a railway testing department should fit in or how it should be related to the railway organization is an important one. It seems to us that the logical place to look for this department, which questions the quality of materials offered or purchased for all other departments and which makes reports thereon to the heads of the departments, should be under some general officer. In our case the testing department has been successively under the engineering department, the stores and the general manager, and is now reporting direct to the vice-president's office; and the most satisfactory relations to all have been while under the general manager or the present arrangement. In our opinion then, the testing department should be responsible only to the management, and while reporting to all other departments, should be independent of them, that is, should be a free lance.

The testing department must necessarily stand close to the general storekeeper, advising him promptly when the material is not of the desired grade and suggesting its disposal or its rejection. We make all of our reports on the quality of materials to the storekeeper, with copies of the reports to the heads of the departments for which the material is intended, and it is taken for granted by the shops that if material is given to them by the stores, it is of the proper quality, and that it has had the necessary inspection. We have always taken the viewpoint that we should be distributors of information of general interest, and in the making of our reports, copies are usually sent to the chief officers in other departments, who are indirectly interested. The testing department can also be of much service to the purchasing department, advising them of the merits of samples as compared with what has been previously purchased, and in working out such specifications as will ensure of their securing a reasonably good commercial material, or article for the purpose intended at a fair price. The cost of inspection, outside of the cost of the material which may be destroyed, varies greatly and may be as much as 5 per cent of the value of the material or as little as .2 per cent.

The making of a specification is a very important part of the duties of a testing department, and the perfect specification should secure the best material at the lowest cost; but in reality the usual specification is very much of a compromise. In drawing up a specification the use of the material should first be carefully considered and the attributes necessary to meet the demands of service well studied. It must then be determined what accelerated or laboratory tests will best show the capacity of the material to meet the service required of it. The departments interested must be consulted regarding the size, shape or form in which the material is desired and the stores must say about the shipping and the storage. The specification must

then be submitted to the purchasing department, who send it out to the manufacturers and after some modification and changes we have a general compromise which gives us a material which will be considered a run of mill product purchaseable at a reasonable price. We know often that material bought in this way is not the best material of the kind made, but it probably is the best material, price considered.

In the use of specifications, the ideal way is to send them to all manufacturers of that particular line, an open market so to speak, and after quotations are received, buy from the lowest priced firm. While this again is theoretically correct, yet it is impossible to ignore the claims of manufacturing companies situated on a railway line, and others who for equally good reasons must be considered, and while the virtues given to materials bought through influence of that sort are of the kind which the engineer of tests is unable to detect, yet where judgment is used and a careful inspection made, this is no doubt good railway politics. Then, again, the skill, equipment, tradition, pride and other factors all have a bearing on the quality of material, and it is a fact that materials bought under the same specification from different manufacturers will differ as to absolute quality, though of course the differences are usually of minor importance and are generally those of finish and appearance.

The difficulty of drawing up and enforcing what may seem to be a reasonable specification is well shown in the case of steel tyres. All railways want a tyre which will wear a long time and which will not break. The tyre manufacturer has taken the view that he should not be told what to make, how to make it, and be held responsible for the result, and then in addition be held down to a price which allows a very small, if any, margin of profit. The result of this disagreement has been that there are very few railways in America today, with tyre specifications upon which tyres are purchased: the American Society for Testing Materials has a specification which is more or less used, and the Master Mechanics' Association is at present drawing up a specification which it is hoped will put the manufacture and purchase of steel tyres on the same basis as rails and similar products. Our company has taken care of this particular difficulty by drawing up what we term a Tyre Standard. This shows the physical qualities of the tyres with which we are being supplied and which are being found satisfactory, so that when a new tyre manufacturer wishes to tender, he is given this standard to consider, and if he can supply the material at a fair price he is given an opportunity and his product is carefully watched to see what results it gives in service. We wish to say here that we have found that the manufacturers of tyres take a pride in keeping up the quality and retaining their good reputation in the same manner in which the conservative manufacturers of some years ago did.

Our specification covering merchant shapes of steel is based entirely upon analysis as being the principal consideration, and steels of different carbons are purchased for particular purposes, thus steel of .25 per cent carbon is used for engine and rod bolts, center plate pins and any place where wear is a consideration .60 per cent carbon is used for knuckle pins and .75 per cent carbon for crosshead keys.

A couple of years ago we added a freezing test to our air brake hose specification. We found difficulty in keeping our train line tight in very cold weather due to the hose becoming stiff, and on investigation it was found that there was a great difference in the stiffness of different makes of hose at the some temperature. We decided finally upon a maximum weight necessary to bend the hose through a certain arc at zero, Fahrenheit, and all air hose supplied to us must satisfactorily pass this test. Since then we have been supplied with a hose of greater flexibility at low temperature, and we may say a better hose too than we previously used.

The manufacture of material, such as disinfectants, boiler compounds and so forth, by a testing department or under the supervision of a testing department, is to our mind a question procedure, and while we are at present making a boiler compound, yet we anticipate at an early date purchasing this material to our formula and specification. We believe that a suitable formula and specification will enable the purchasing department to buy any material with greater satisfaction for use than can be given by intermittent manufacture with all its drawbacks due to irregularity of the quality of raw materials, changes in the workmen during the manufacture and other variable factors. We believe that the following definition of a railway given by Mr. Julius Kruttschnitt, of the Harriman Lines, covers the situation, "A railway is a machine designed to manufacture freight and passenger transportation, it makes ton miles and passenger miles." From a limited observation of railway manufacture, we consider that the great majority of railway materials can be purchased outside with greater satisfaction and economy than they can be made, and we may mention such things as bronze, brass, and steel castings.

The management of the iron mixtures for our foundries is one which has effected a very large saving as compared with previous practice. All of our mixtures are carefully calculated from the analyses of the materials entering into the mixtures and the uniformity of the product is an evidence of the value of this. In our wheel foundry the difference between wheels too hard or too soft for use and good wheels is only a few hundredths of a per cent of silicon or manganese so that great care must be exercised in the choice of materials. In the grey iron foundry we produce three different grades of iron, each day from the same cupola: cylinder, machine and a common iron for grate bars and such castings. Every car of pig iron and coke received is analyzed, as is also our limestone and scrap from time to time, in order to check them.

The scrap dock has been a popular direction for many testing departments to turn to to effect economies, and the following are among the principal items considered in a paper recently read before the Central Railway Club by Mr. J. P. Murphy, general storekeeper of the L. S. & M. S. Ry. Knowing how dear economies in scrap material are to the average railway man and appreciating its importance we quote this in full.

"All bolts and iron suitable for making bolts are assorted, straightened, cut to length, threaded and turned into stock for further use.

"Washers are made from old sheet on a punch which is available for the purpose.

"Nuts are sorted to size and retapped.

"Track spikes and bolts fit for further service are returned.

"Tie plates, angle bars and rail braces are sorted out, the plates often repunched to other sizes, rail braces straightened.

"Coupler pockets sheared from couplers by a hydraulic press and reissued.

"Old bridge channels and angles made into angle iron face plates for cars.

"Frog and switch parts dismantled, and good parts assembled for use in manufacture of new frogs and switches at our rail shops.

"Passenger brake shoes unfit for that service sorted and delivered for use on freight cars.

"Brake beams repaired.

"Forgings capable of being worked over sorted.

"Journals bearings relined.

"Air hose refitted and old couplings used.

"Splice hose for work equipment.

"Throttle packing made from scrap hose.

"Union gaskets made from old air hose gaskets.

"In the handling of scrap the same is sorted for mill classification, thus allowing the purchasing agent to obtain better prices for it."

There are undoubtedly many things to be learned and economies to be effected from an investigation and study of materials at the scrap dock, and our locomotive and car departments are watching this very closely. Our investigations into

re-using scrap materials have been very limited, but one included the recovery of oil from discarded dope, and without entering into details we may say that this recovery was an economical proposition when nothing was allowed for the scrap value of the dope, but when the reclaiming process was charged with its market value the proposition was non-paying, to say nothing of the trouble which the use of the reclaimed oil made because of its inferior quality. We have heard of washed waste, which no one wished to use, and of recut files which it was difficult to have mechanics give a fair show to, and it is our opinion that if some of these so-called economies are properly investigated, it will be found that if they bear all the charges which should properly be set against them, that the saving is very small.

The inspection of failed material is made together with a representative each from the drafting office and the shops, so that the question of design, and fit or workmanship, can be considered before chemical and microscopic analysis and physical testing are done. The results of these investigations of failed materials are usually the finding of inferior material, otherwise there follows modifications of design, variation in shop treatment of material or a change in the specifications for the materials used.

We have done a great deal of testing during the last few years of high speed steels, and drills of different designs made from these steels. We have made tests of files and are called upon continually to judge as to the merits of different brands of shovels, handles, lanterns, hose and many other small devices and materials which it is difficult to satisfactorily cover with a specification. Studies are being carried on relating to steel tyres, cast iron wheels, rubber hose of various kinds, and paints with a view to seeing what improvements can be effected which will result in greater economy to our company.

Paints have always been a favorable and a necessary field for the investigation of the railway testing department, and great difficulty is experienced in securing the materials which are specified. No one will question the knowledge which the paint maker has regarding the use of paints and the attributes of the materials which he uses, but the greatest objection which we have found is that the paint manufacturer does not always seem desirous of carrying out the requirements of the specifications which a railway company draws up, and he tenders on, but prefers to supply the materials which are the best in his judgment. We do not wish to be unfair to the paint manufacturing business, but we believe that more sophistry is practised in that branch of the manufacturing business than any other that we know of.

The sampling of materials is a very important and difficult matter and often does not receive the attention which it should. A sample must be representative of the average quality possessed by the material of which it forms a part, so that judgment and care are necessary to prevent a selection of the best or the worst portion of the material that it is desired to sample.

The forms for reports is a most important consideration and is something upon which a great deal may be said for each particular material and condition requires its own treatment. However, we shall not elaborate on something which is not of general interest, though we may say that we make all ordinary reports in letter form as we think they receive more attention and consideration.

Before closing we wish to say a few words about the supply men whom we have come in contact with, and we may tell you that in all the reports made either for or against materials we have not found any who were not willing to believe that the work had been done impartially and who were not ready to give our work reasonable consideration.

We are sure that we have only touched on the question of a railway testing department in this paper, but if we have stimulated some little additional interest in that work or have called attention to work which has hitherto passed unnoticed we feel that our effort has not been in vain.

MEADOW VALLEY RECONSTRUCTED LINE, S. P., L. A. & S. L. R. R.

The San Pedro, Los Angeles & Salt Lake line from Milford south lies in Clover Valley. The original project was conceived by the Union Pacific. In the reconnaissance surveys, this valley was found to be the logical route of descent from Milford to Meadow Valley. South of the latter valley was a region with a natural gradient which could be easily adapted to the railway line. The preliminary surveys showed that the route via Clover and Meadow Valley was far superior to any others. Meadow Valley cuts through three ranges which run in the desired direction, and necessitated no heavy grades. The sides of Meadow Valley are precipitous, but usually there was room for the grade between the foot of the slope and the stream. The length of the line through the two valleys was 113 miles.

The first line located through this valley required only a small percentage of heavy work. The fills were, in general, low, in fact only high enough to give easy construction, and to take utmost advantage of the natural ground surface. This is the policy frequently pursued in building lines through a new or unsettled country, the idea being to improve gradients, curvature, etc., later if the traffic warrants it.

The grading for the Clover Valley section was completed in 1890, but work was discontinued at that time as the Union Pacific went into bankruptcy. Work was not started again until

East of Caliente, S. P., L. A. & S. L. R. R.

1901, at which time the work was continued by the San Pedro, Los Angeles & Salt Lake, in which the Union Pacific had a half interest. In the eleven years that had elapsed no floods had occurred, and practically all of the grade remained intact. Much of it was used in the construction, which was completed in 1905. In 1906, immediately after the completion of the line, a small flood occurred which tied up the line for two weeks. In 1907 came the highest flood ever recorded in the valley.

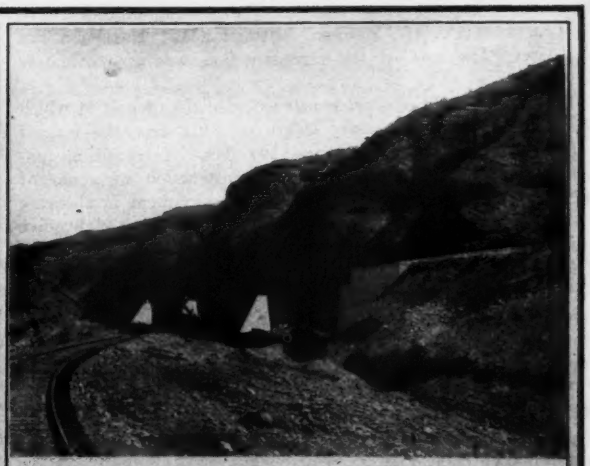
This flood tied up the road for six weeks, and showed the necessity of making a number of changes in alinement and of raising portions of the grade. The work at that time included placing over 30 miles of rip-rap, putting in 8 steel bridges to replace destroyed trestles, changing the alinement of the track and making new channel for the creek in a great many places. In January, 1910, came a still greater flood than that of 1907,* caused by a heavy rain on top of a very heavy snow fall. This flood closed two-thirds of the line.

The necessity for relocations and reconstruction of practically the whole line was shown by these floods. A new "high line" was located 8 to 12 feet above the high water line of 1910, using very little of the old grade.

Alinement, and therefore distance, has been a secondary consideration to safety. The new line is approximately two miles longer than the old one. Maximum curvature is 8 degrees; maximum gradient is 1.5 per cent, which is the same as on the old line. For the reconstruction, 85 lb. A. S. C. E. section rails with continuous joints have been used, with 18 ties per

*Railway Engineering and Maintenance of Way, May, 1911, p. 293.

NEW HIGH LINE
NEAR KYLE, NEVADA., S.P., L.A. & S.L.R.R.



THREE-SPAN GIRDER BRIDGE
WITH CONCRETE PIERS AND ABUTMENTS ON
NEW LINE WEST OF GALT, NEVADA.

CANYON EAST OF CALIENTE.
NEW LINE AND TUNNEL AT RIGHT.
OLD LINE AT LEFT.

PALISADE CANYON,
NEVADA. TRAIN ON NEW HIGH LINE.

RAINBOW CANYON,
NEVADA. TRAIN ON NEW LINE.

NEAR CARSONS,
NEVADA. TRAIN ON NEW LINE.

33 ft. rail. Treated Oregon fir ties (burnetizing process) have been used exclusively, equipped with standard Harriman flat tie plates. The cost of the reconstruction was approximately $5,000,000.

The heaviest work was the construction of the tunnels of which there are ten with an entire length of 5,972 feet, the longest being 1,300 feet and the shortest 300 feet. A record in tunneling has been established in the construction of some of these tunnels, progress having been made in them at the rate of fifteen lineal feet per day. Originally there were eighty-five crossings of the stream in the canyon, spanned by trestle bridges. The new high line avoids sixty-one of these crossings, and at each of the remaining twenty-four there has been installed steel girders and trusses which fully span the channel and rest on massive abutments and piers. The entire length of the twenty-four bridges aggregates 4,925 feet.

A large amount of concrete has been used for piers and abutments, and also for a number of retaining and bank protection walls. The total amount of concrete used was approximately 34,000 cubic yards.

New Line Near Galt, Nev., S. P., L. A. & S. L. R. R.

MAKING AND PLATTING SURVEYS FOR REPLACING STRUCTURES.*

Survey for New Structure.

Surveys are made to determine the proper size and most economical type of structure to adopt, and what is wanted is a full recommendation with sufficient information to check the recommendation and make a decision, and to furnish the designer with all information necessary to prepare the plans.

Secure information in the District Engineer's office relative to contemplated change of grade or alignment, probability of second track construction, width of right of way owned, and the proximity of Division Bench Marks.

Note the alignment of the track at the bridge and consider whether there is any evident reason for a change.

Consider the question of second track construction in connection with any change in the alignment or in the location of the bridge. Conclude on which side of the present track the second track should be constructed and make note of your conclusions with reasons for same. Ascertain the degree of curvature of all curves within the limits of the survey.

If the structure has been previously surveyed, use the same stationing. Tie up the stationing, approximately at least, to some section line and indicate on the survey with what station of the "Original Profile and Right of Way Map" same corresponds.

Make note of the plus of all switch and frog points, points of curves, center and fence line of public highways and farm crossings, center line of track and right of way lines of intersecting railways, each end of all bridges, and center line of culverts within the limits of the survey.

Take the plus of all pile and timber bents, abutments (at face) and the center line of bearing on piers and abutments of the bridge being surveyed.

If a former survey of the bridge has been made, use the same datum; if not, use the Division Bench in case there is one in the immediate vicinity; otherwise use an assumed datum. Take a reading on any City or U. S. G. S. bench that can be conveniently reached.

Establish and note one bench mark on each side of the bridge, on permanent objects, which are unlikely to be disturbed during the construction of the permanent work.

Consider the question of a change of grade; note the kind, depth, and condition of ballast, and other points that will be of assistance in determining the expense and practicability of making the change.

The width of railroad at subgrade should be determined at either end of the bridge and for a distance of at least 600 feet therefrom, being measured at intervals of about 200 feet.

Determine the elevation of the base of rail across the bridge and at each of the previously established stations and plusses. Ascertain the superelevations of the outer rail at each station where the bridge is located on a curve.

Obtain notes as to the elevation of the ground surface that will be covered by and in the immediate vicinity of the proposed structure, by measuring down from the base of rail to the ground at each bent, and secure sufficient cross section notes on either side of the bridge to enable one to draw an accurate contour map of the situation.

*Abstract from a pamphlet of instructions for making and platting surveys for designing new structures to replace old ones, C. M. & St. P. Ry., C. F. Loweth, Chief Engineer.

Existing Structure.

Make note of the size and length of ties of the existing structure, kind and size of guard rails, size and number of stringers per span, number of piles per bent, and if same are badly skewed or out of plumb the batter and skew of the bent should be determined and the plus or station of same at the ground line noted.

Make note of and show on the survey any electric light, telephone, or telegraph wires that may be attached to or pass through or beneath the bridge.

Obtain complete notes of and show on the survey all bank protection, riprap, and existing masonry; make such sketches as may be necessary to clearly show the condition of the latter. Determine the elevation of each bearing plate or surface on existing masonry.

Take measurements to and show on the survey all fence and right of way lines. Ascertain whether any additional land or right of way is required for any purpose in connection with the work, and report your findings with recommendations.

Ascertain the nature of the foundation, whether soft and requiring piles, or of sand, loam, or clay. State as to the character, depth, and dip of the strata. In almost every case an open test pit should be dug, and an occasional bearing test should be made to supplement your judgment as to the safe allowable bearing on soil or on piles.

Make a full and complete recommendation. Give size and type of structure proposed, with the depth to which the footing should be carried, and the safe allowable bearing on soil or on piles if same are required. Give also the location for the center line of the proposed structure with the angle that same is to make with the center line of track, together with the angle of all wings. If the structure is an undercrossing, give present and proposed elevation of the driveway.

Waterways.

Take notes for and make sketch of the water course for a sufficient distance above and below the bridge (not less than 200 feet for small or relatively unimportant structures and correspondingly greater for more important ones) to determine whether a change in location or improvement of the channel is desirable, and make your recommendations in regard to same.

Take levels so as to show a profile and the average fall of the bed of stream for a distance of at least 200 feet above and below the bridge, and indicate the direction of flow.

Ascertain low, present, ordinary and extreme high water elevations. Inquire into the cause of such high water, whether by ordinary heavy rains, cloud bursts, damming from the accumulations of ice or drift, overflow or back water from other streams, or from other causes which may be apparent. Note the probability of ice, driftwood, etc., lodging against the structure. Ascertain, if possible, the general direction of flow during high water.

Take one or more cross sections of the channel above the bridge and determine the high water discharge area at each of those places and at the bridge. If there is another bridge over same stream, either above or below this one, and within a reasonable distance, secure a transverse profile of the stream, an elevation of the bridge, and the high water discharge area at such bridge to assist in arriving at a decision for the bridge under consideration.

Secure all available information relative to any present or proposed drainage ditches both above and below the bridge, for which in time we may be called upon to provide waterway.

Undercrossing.

Satisfy yourself as to the need for each cattle pass and farm crossing and determine if it is feasible and permissible to close the same. If so, investigate and report as to the expense and practicability of providing a grade crossing. State on the survey just what investigations you have made and the information secured.

For highway undercrossings, locate the actual intersection and measure the angle of the center line of the established highway with the center line of the railway, the actual width of the dedicated highway, together with the position of the main traveled portion of same. Measure the clear height and width of existing opening.

State as to the relative importance of the highway, whether used by many or only a few farmers and also whether it is a County, Township, or State Road. If the highway has side ditches or drains, is graded up or otherwise improved, same should be noted and shown on the survey.

Secure a profile of the highway for a sufficient distance each side of the bridge (never less than 300 feet) to determine if any change in the grade of same is desirable or permissible, and the proper drainage for same. Report the jurisdiction over said highway, whether County Supervisors, Highway Commissioners, or the Circuit Court.

For railway undercrossing, measure the horizontal and vertical clearance, and secure a profile for 1,000 feet in each direction, and measure the angle of intersection of the two railways.

Bridges Within Towns.

If the existing bridge is used by the public, report who has jurisdiction over same.

The location and elevation of all contiguous underground telephone, telegraph, and electric light conduits, water and gas mains, sewers and tunnels must be determined and shown on survey.

Secure from the owners of such underground properties a map showing their approximate location, and verify same by actually uncovering those that are liable to be disturbed or interfered with by excavations, falsework, or the permanent structure.

All manholes, catch basins, curbs, sidewalks, street paving, etc., adjacent to or having any connection with the structure should be shown on the survey.

Platting Surveys.

Surveys are not to be too elaborately made. Neat and plain legible lettering and title are desired, and the recommendations should be written on the survey instead of being lettered. Special features should be stated on the survey instead of in a separate letter.

All information called for in the foregoing, relevant to the particular class of structure being surveyed, should be shown on the survey in a compact form and concise manner, and the Assistant Engineer should write his recommendation on the survey before the same is handed to the District Engineer who will write his recommendation thereon and forward to the Engineer of Masonry Construction.

The various data should be so assimilated as to cause the least possible amount of work on the part of the Chief Engineer in observing the governing features and formulating his decision, and to this end arrange the data in about theorder hereinafter mentioned:

Surveys should be oriented to time table directions; i. e. East is always "Toward" Chicago and on the survey is to be shown to the right, but the true meridian must be indicated also. In showing a section or profile at right angles to the track, the time table north end of same is to be shown to the right.

The survey should contain the following information and general notes and any in addition thereto which may have bearing on the particular structure, and these should be put in the upper right hand corner of the sheet:—

Location.
Bench marks.
Alignment (present and proposed).
Grade (present and proposed).

Superelevation.
Ballast.
Width of roadbed at subgrade.
Present structure.
Undercrossing information.
Drainage area.
High water elevation.
High water discharge area.
Low water elevation.
Drift wood, ice, etc.
Additional right of way.
Foundation.
Recommendation of Assistant Engineer.
Recommendation of District Engineer.

To the left of the general notes and near the top of the sheet, draw a longitudinal section of the bridge to the same horizontal and vertical scale of say 1 inch to 10 feet. This must show the plus or station of each end of the bridge, each pile or timber bent, center line of bearing on all piers and abutments, the profile of the present and established base of rail, original ground line previous to the construction of the roadbed, an elevation of all masonry and riprap, high and low water elevations, high water discharge area expressed in square feet, and the clear height and width of the existing highway or driveway openings indicated by direct dimensions.

Immediately above the base of rail as shown and near the middle of the bridge, indicate the bridge number in fairly conspicuous figures.

Directly beneath the longitudinal section, and near the bottom of the sheet, draw a plan of the bridge to the same scale and sketch the contours in brown or red to a two foot interval.

Show all fence and right of way lines, edges of bank or stream, position of main traveled roadway, and the intersection angle of the center line of the dedicated highway with the railway. Show by an arrow the direction of flow during ordinary water level, and the general direction during high water.

Next to the left, and near the top of the sheet, sketch the outline and salient features of the drainage area, indicating the location of other bridges in the vicinity, giving the acres drained and such other information as may be necessary to clearly bring out the controlling features of the drainage area.

Beneath this show the cross sections of the stream and their respective high water discharge areas, together with any similar information that may have been secured for other bridges in the vicinity.

Near the bottom of the sheet draw, to a scale 1 inch to 100 feet horizontal and 1 inch to 10 feet vertical, a cross section of the dump and a profile of the stream or highway as the case may be.

At the left end of the sheet, and near the top, draw a profile of the existing base of rail and the original ground line to a horizontal scale of 1 inch to 100 feet and a vertical scale of 1 inch to 10 feet, for the full distance that the levels were run. Indicate both the present and established future base of rail, and the high and low water levels.

Beneath this profile, draw a profile of the base of rail to the same horizontal scale but to a vertical scale of 1 inch to 1 foot. If some part of this last named profile crosses part of the platted work, there is no objection thereto.

Beneath the profile and to the same horizontal scale, draw a general plan covering much more ground than the large scale plan; the contours on this need be sketched in for the five foot intervals only; however, the fence and right of way lines, must be shown and the stream sketched in for at least 200 feet each side of the bridge, for the smaller structures, and correspondingly greater distances for the more important ones. If any channel change is proposed or other improvements recommended, same should be sketched in pencil on the general plan.

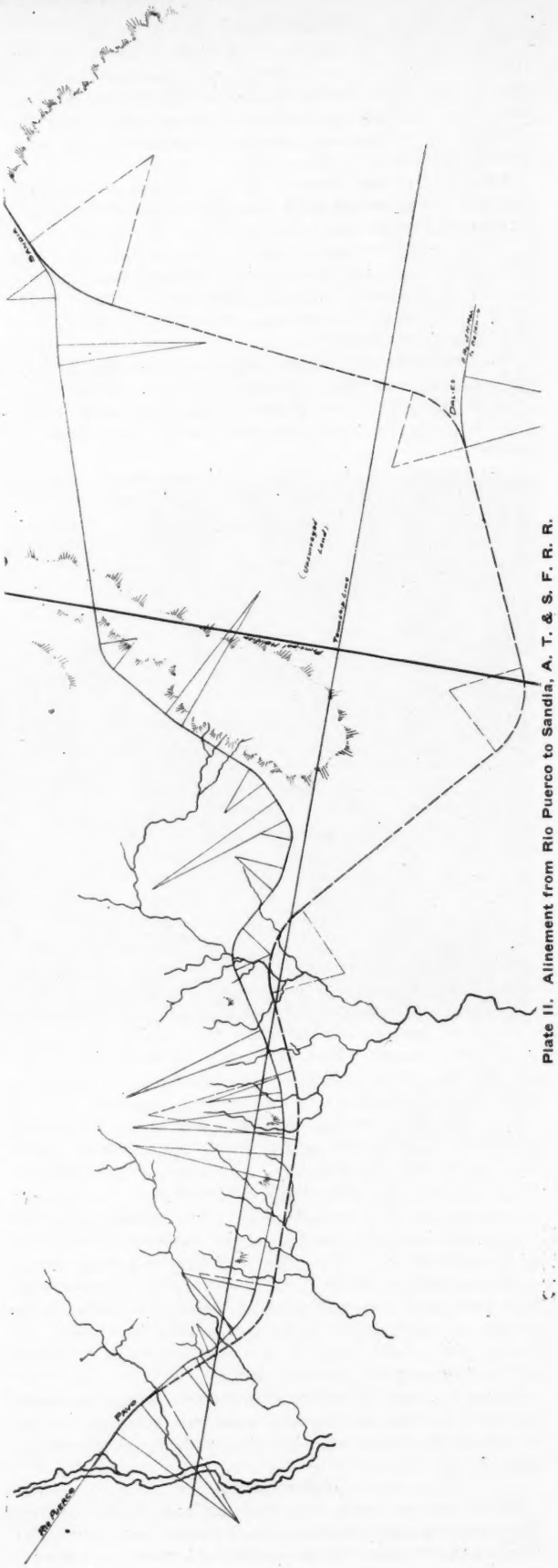


Plate II. Alinement from Rio Puerco to Sandia, A. T. & S. F. R. R.

Rio Puerco Grade Revision, A. T. & S. F. Ry.

J. G. Van Zandt, C. E.

The making of a great railway system is never without its chapters of interesting, not to say romantic, history. The many races between rival roads for the best location in some pass or canyon, the conquest of new arid deserts, with Indian tribes to combat and terrific sand-storms to face—in fact, the incidents of disaster or success would make subject matter for a most interesting volume. The old "Atlantic and Pacific Railroad" which followed the "Santa Fe Trail" across the many deserts and ranges from Albuquerque, New Mexico, to San Francisco, was not without its share of interesting incidents. The development of the present Santa Fe system has been largely made possible by the successful location of this early transcontinental line, and while the growing demands of commerce have made grade revision necessary at this time, it is of interest to note that, even in the light of later surveys, the original location is remarkably commendable.

With the development of the Eastern nucleus of the system at Topeka and the topographical inducements to locate through the pass at Albuquerque on the western route, there was a further step taken in the prospect of this "desert road," so that at present as the far western termini increase the moment about this fulcrum, there is an ever increasing demand made upon this connecting link which is the only one south of Salt Lake and north of El Paso at the Mexican border.

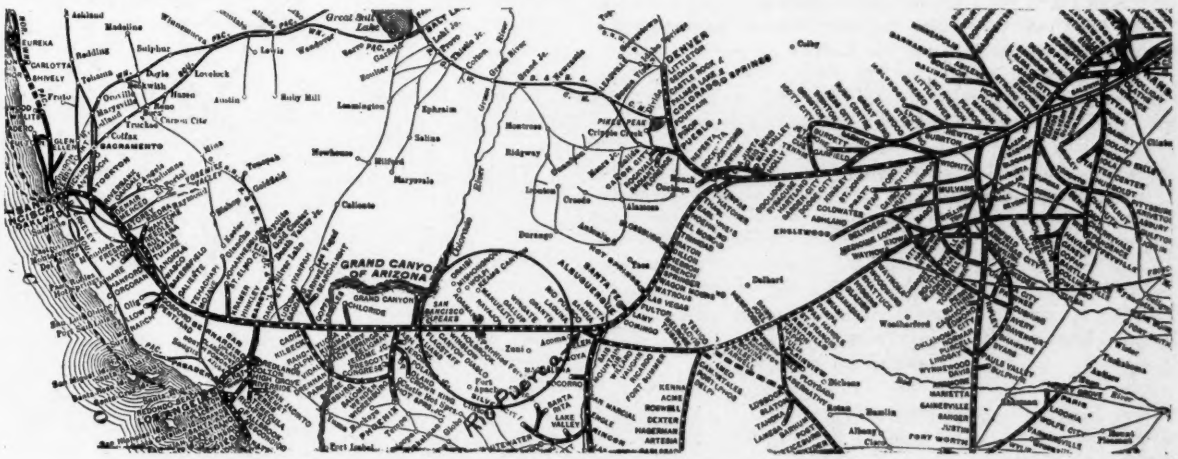


Plate I. Santa Fe System, Rio Puerco Division Shown in Black Circle.

The importance of this connection is at once evident from the chart of Plate I, which is a diagram of the system showing this stretch enclosed in a circle to emphasize its value to the remainder of the system. At the eastern end the subsidiary road, "Eastern Railway of New Mexico," also the branch from El Paso and the northern main-line converge to intensify the traffic, while at the western end the Phoenix line and the main-line similarly converge. This condition has naturally enhanced the importance of this connecting link and has made grade-revision and second-track work imperative.

There is no question but that the necessary expenditure for a second track construction would be justifiable, especially if a relocation and grade revision could be made at the same time. The original ruling grade was over one per cent, which would naturally be expected on an original location in a mountainous district where first cost must be a minimum. On the other hand, the distance and amount of curvature in the alignment would necessarily suffer if a lower grade was to be maintained, since the country would not permit much improvement in the location. The relative importance of these items in the economics of the problem may be best studied by making a comparison of the new and old locations. Taking the problem as a whole the reduction of the ruling grade of the entire division from about 1.4 per cent to 0.6 per cent would affect a very large saving in the cost of operation and undoubtedly offset the increased cost due to longer distance and more curvature. There would, of course, be an increase in average cost per train-mile due to operating fewer trains of heavier tonnage among which all fixed charges must be divided. The elimination of pusher service at many isolated points is also an important feature of this grade revision since this item practically doubles the cost of operation on the hills.

It has been estimated that the justifiable expenditure for a reduction in the tonnage rating on the entire division to a ruling grade of 0.6 per cent would be about twenty-two and one-half million dollars or nearly one hundred and fifty thousand dollars per mile. In many places the grade of the original line is less than 0.6 per cent so that in double-tracking, grade revision would not be necessary and all that would be required would be to widen cuts and fills, reconstruct bridges and culverts and possibly adjust the alignment so as to accommodate the additional track without unnecessary expense. In many cases this improvement where no change of grade is made would average less than ten thousand dollars per mile, so that the balance of the "justifiable expenditure" for the division would be available for the steep hills and other places requiring more expensive improvement.

The Rio Puerco grade is one of the most interesting of these problems where the revision necessarily involves a considerable expenditure. The rise and fall from the eastern summit to the river and thence to the western summit is something over a thousand feet and the country is rough and mountainous. The original location followed the general slope of the country on about whatever grade the support appeared to suggest. The alignment, however, was remarkably good and while there were some curves of high degree these were few and generally the tangent lengths were long for such a location.

On the east of Rio Puerco there is an irregular one per cent grade for about six and one-half miles. From the map on Plate I it is evident that the convergence of the Eastern Railway of New Mexico and the main line occurs at the river crossing and from Plate II it will be noticed that the two lines diverge slowly for some distance. The grade of the Eastern Railway of New Mexico is not so great as on the main line since it follows the gentle slopes down stream and passes eastward around the highland over which the main line passes.

An economic solution is forcefully suggested in the topography of the country which permits of an easy grade and an inexpensive connection from this subsidiary line at Dalies to the main line at Sandia. This is but three and a half miles in length and has a comparatively light grade with no curves but those at its ends. The first cost averages less than fifteen thousand dollars per mile. By this arrangement east-bound freights avoid the steep hill, though the line is about two miles longer. The saving in rise and fall together with the advantage of the lower grade more than offset the increased cost due to the increased length of the line and the charges of interest, taxes, maintenance, etc., from this new investment. It would be the intention, of course, to use the original line for west-bound freights thus completing a second track arrangement in connection with the grade revision. The cost of descending a very steep grade is recognized as somewhat greater than for light grades, especially if the excessive use of brakes is necessary. This item recurring in the cost of each train which was operated over the line would materially increase the total so that there would be economy of operation if all heavy trains used the lower grade for both directions leaving the other line for passenger service. This being a desert country and practically uninhabited it is not a serious matter whether or not all trains of one kind pass over either line nor is there any reason for both lines requiring both, so the solution is purely economic.

On the western side of the Rio Puerco there was no such opportunity for improvement. The ten miles of irregular one per cent grade up the hill seemed a natural location. An extinct volcano on the west bank of the river cut off all escape down the stream and a relocation winding along the slope of the hills on the south offered the best support. The alignment shown on Plate III is very interesting as it shows the comparison of the new and original location. While there is a loss of 1.27 miles in distance the profile shown on Plate IV indicates that the location succeeded in securing support for a uniform 0.6 per cent grade for its entire length. A comparison of the two lines reveals the following:

Table of Comparison of Lines.

Item	Old Line	New Line	Difference
Length	12.94 miles	14.21 miles	+1.27 miles
Curvature	107 degrees	397 degrees	+290 degrees
Number of Curves.	7	11	+4
Maximum Degree..	4 degrees	3 degrees	—1 degrees
Grade	1.0 per cent	0.6 per cent	—0.4 per cent

An economic study of the justification for the expenditure of the necessary investment in this improvement should properly include benefits derived in other parts of the division due to this grade revision. In order to make an illustration of the subject presented without attempting to give an exhaustive treatment of the entire problem, the cost and value of this one grade as an isolated unit is here given. Assuming present prices for construction the estimate of the cost for this second tra between Rio Puerco and Suwanee would appear to be about as follows:

Table of Estimated Cost of Construction.

Item	Unit Cost	Total Cost	Remarks.
Right of way...	$2.50-A.	$ 500	Nominal price. Unsurveyed land.
Earth excavation	.15-yd.	6,255	Sand and loose earth.
Loose rock.....	.40-yd.	3,520	Gravel and boulders.
Solid rock.....	.90-yd.	14,580	Mal pais, lava, etc.
Steam shovel.....	.60	24,300	Boulder clay.
Steam shovel.....	.30	13,200	Sand, Etc.
Embankment	.15	41,835	All material (no overhauling).
Bridges		4,000	One plate girder.
Culverts		1,600	Two 26-ft. I-beam spans.
Concrete		2,000	Two abutments.
Pile trestle.....	10.00-ft.	3,780	378 lin. ft.
Pipe culverts (48")	.10-ft.	2,280	Cast iron.
Pipe culverts (36")	.065	624	Cast iron.
Pipe culverts (30")	.05	480	Cast iron.
Track raising.....	.20-ft.	1,000	Old Track.
Track lowering..	.25-ft.	125	Old Track.
Temporary track	$1,000-mi.	570	Work track.
Side track.....	7,500-mi.	11.925	Permanent.
New main track	8,800-mi.	115,016	Permanent.
Total		$257,590	$18,127 per mile.

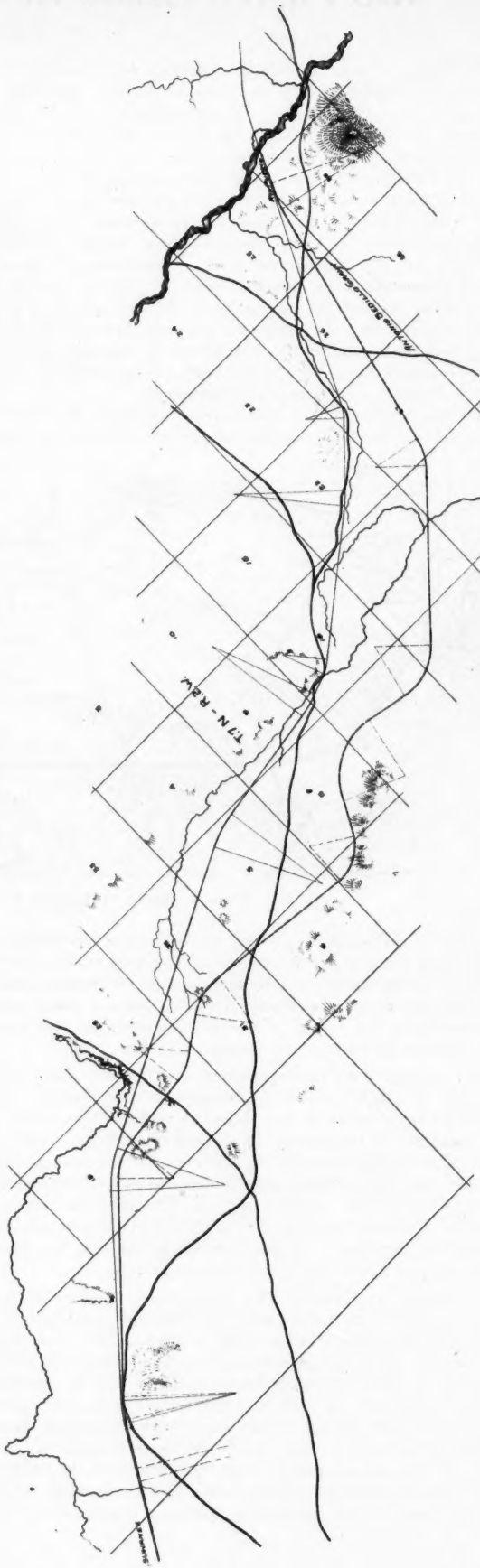


Plate III. Alinement From Swamee to Rio Puerco.

The character of the work naturally required first-class construction in every particular so that many features became more expensive than they had been in the original line. The road-bed was made 20 ft. wide in fills with slopes 1½ to 1 and in earth cuts 28 ft. wide with slopes 1 to 1. In solid rock, in which there were numerous cuts, the road-bed was reduced to 24 ft. in width with side slopes of ¼ to 1. Where the steam shovel was employed the cuts were made 30 ft. in width and the slopes left to find their natural sliding angle. A summary of the value of this investment would be about as follows:

Table of Summary of Value of New Line.

First Cost of Construction—1421 miles at $18,127	$257,590
Maintenance: Curvature—397 degrees at $35	13,895
Rise and Fall—405 feet at $125	50,625
Fixed Cost of Operating—14.21 miles at $30,000	426,300
Capitalized value—(52,668 per mile)	$748,410

The actual first cost has been found to come very close to the estimate and with increasing traffic the items of maintenance will approach the amounts allowed more closely. The fluctuation of the commercial demands upon this line and the corresponding irregularity of traffic makes any estimate of this kind necessarily approximate, but assuming average conditions

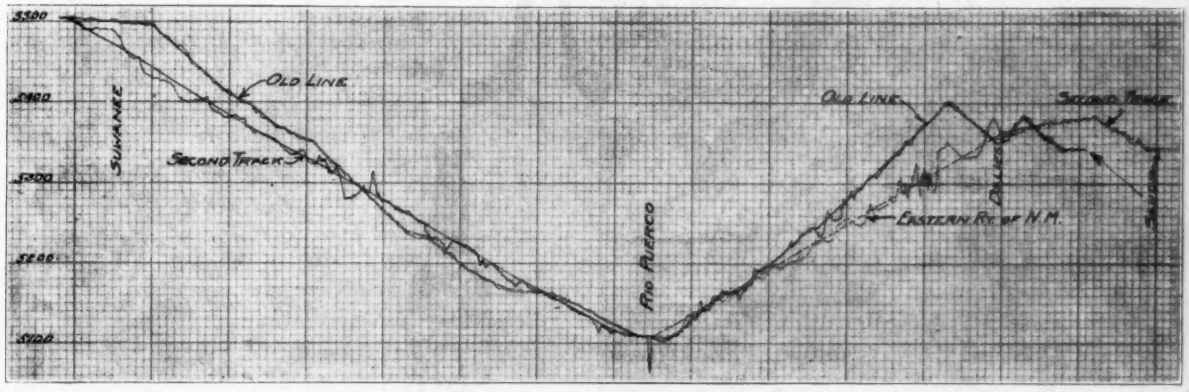


Plate IV. Profile of Rio Puerco Grades, A. T. & S. F. R. R.

it appears that upon this section considered as an isolated unit, there would be a saving due to the reduction of grade of at least four daily trains. This would give a corresponding decrease in the cost of transportation of a given total tonnage on the train-mileage basis. All of the cost of operation, of course, is not dependent upon train-mileage, and it is generally agreed that about one-half of the cost may reasonably be assumed to vary directly with this item. With this as a basis of computation it appears that the justifiable expenditure (at 5 per cent interest) would be about $26,000 per mile or about $8,000 more than the estimated first cost of construction. This is the saving without taking into consideration the far more important value which this improvement means to the rest of the division, or as a strategic link in a great system. If it is true as before suggested that the saving to the entire division may be assumed to be as much as $150,000 per mile as an average it appears that in this case the total may be considered of great value as the grade revision would more than pay for itself as an isolated unit and include the abandonment of the old location without credit.

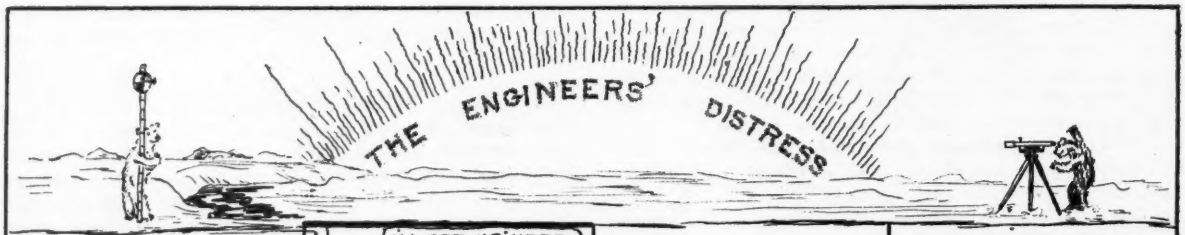
In conclusion it may be said that no doubt a more complete and exhaustive study of the entire problem would reveal many items both of benefit and of loss which are not mentioned here which would alter to some extent the figures given, but it appears that there need be no question that the investment in the grade revision at Rio Puerco is money well spent. It is just as possible for a road to out-grow its location by increased traffic and save interest on a grade revision, as it is possible for a tunnel to finally be justified by traffic demands which would have been unreasonable at the time of first construction. There are doubtless many places in which a careful study would reveal unexpected values in grade-revision and as traffic grows it is doubtless good policy for any road to investigate its location with a view to stopping the leaks and patching the outgrown sags and summits where an immense saving can be made.

STEEL SCREW PILES.

Steel screw piles were employed as foundations for a temporary falsework used in repairing a railroad bridge at Benha, Egypt, on the line between Cairo and Alexandria. The bridge spans the Nile at a point where the current is unusually swift and where in time of flood any obstruction to the current results in severe local scouring of the bottom. Wooden piles were first employed on this work, but were unable to resist the force of the current. The piles employed had an outer helical diameter of about 47 in. and a pitch of about 6¾ in. The base of the point is 10 in. in diameter and is equipped with a serrated cutting edge 1⅛ in. thick. The point is 17½ in. deep and fastened to the shaft of the pile by a flanged joint. The shafts are 24 ft. long and about 14 in. in diameter and are made up of steel plate 0.6 in. thick with the edges fastened with a longitudinal butt joint splice. A space of about ¾ in. is left between the edges of the shell at the splice, forming a groove extending the entire length of the pile section. This groove serves as a means of controlling the pile while driving. Additional sections of the shaft are attached by means of flanged collars placed on the inside of the shaft and fastened with countersunk rivets. These joints are made water proof.

The piles were driven by means of a horizontal winch with a center boss a little larger than the pile section. The driving machinery was located on two lighters fastened together with timbering and securely anchored. The piles were guided to some extent while driving by means of wrought iron collars attached to the lighters at three different levels. The engineer in charge of the work, Mr. Van Ringh, is quoted in a recent issue of "Nouvelles Annales de la Construction" as stating that considerable difficulty was experienced in driving the piles beyond a depth of about 24 ft. To relieve this a water jet was used in the interior of the pile, supplemented by a second jet employed on the outside. These jets were operated by Worthington pumps, and it is stated that their use, combined with a slight gyratory motion imparted to the pile while driving, resulted in the satisfactory placing of the piles to the required depth of about 59 ft.

When the piles were driven they were tied together with specially designed steel beams upon which the necessary false work was erected. At the completion of the work the piles were removed by a reversal of the operation employed in placing them.—*Engineering Record.*



BOOST and the world boosts with you,
BUST - and you are alone.

IS THIS OUR FUTURE?

There was a young man from Lorraine,
Who was hired to handle the chain,
But a hookworm did lurk,
And made him shirk in his work,
So they kicked him out into the Rain.

IT MADE MILWAUKEE FAMOUS
BUT
I LOST MY JOB.

MY PROFESSION

Some talk of going farming,
Some talk of taking law,
Some talk of being bummers,
And stay at home like Pa,
But of all the ways of working,
The one that is for mine
Is to work like a fool,
And pack like a mule
On a "d-d" old survey line.
You hit the swamps at day break,
You pull the darned old chain,
You stick that cussed rod up
In the face of driving rain,
But of all the ways of working
The one that is for mine,
Is to work like a fool
And pack like a mule
On a "d-d" old Rail-Way Line

1912 LEAP YEAR

Look out Mr Engineer for 1912 is a leap year and you cannot take any chances whatever. You have heard the old gag about "two-living as cheap as one," but they can tell that to "Sweeney." You know that its a common "hunch" that when a man gets married he generally has something running around his yard besides punkins, and your salary will hardly permit anything but single blessedness.
A slump may happen too, at any time, and you know what you got in the last one, they offered you a job as Road Master's clerk. So take care, dont take any leaps that you will regret.

A REMINDER FOR THOSE WHO HAVE SERVED.

HOMEWARD BOUND

EVOLUTION
OF "SKINNY" THE RODMAN.

The Company had a rodman once,
"Skinny" was his name,
"Gazella" he was often called
Alias the sand hill crane.

But to take a bath he would not do,
For much afraid was he
To pull the plug when he got thru,
For in the sewer he'd be.

For all o' this he was right smart
To rod a mile or two,
But when it came to chaining,
He ne'er knew what to to do.

When "skinny" would have to drive a peg
He would always say he'd tag,
And then he'd pull out his "makens",
And roll himself a drag.

Next skinny got a pension job,
He was a draftsman, so they say,
And sat upon a big high stool,
And whiled his time away.

Unknowing, our friend gave up the game,
But on the road he still trod,
For EVOLUTION finally came
And changed him into a ROD.

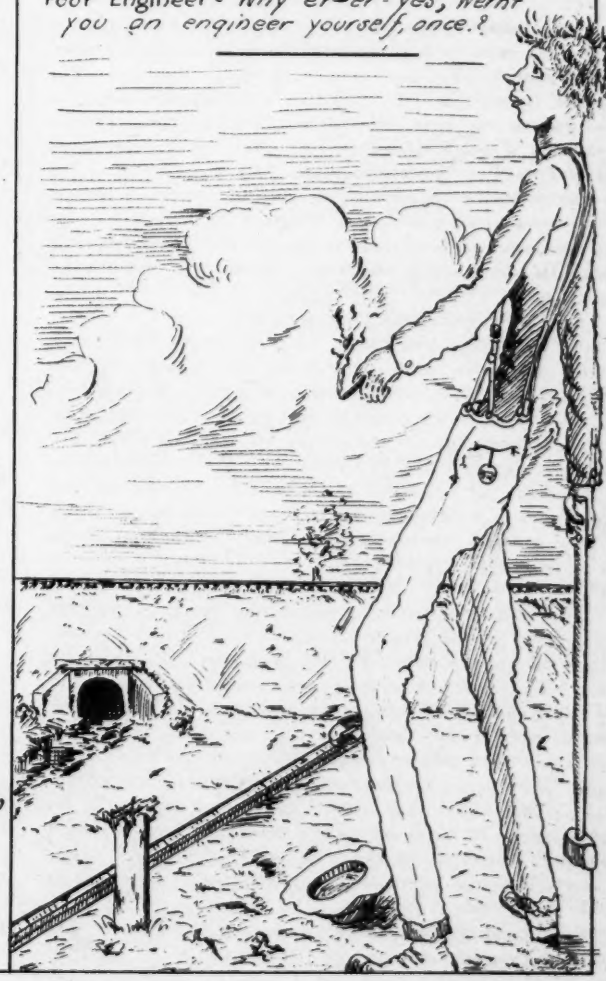
"The Transit Box"

Green Rodman to Asst. Engr - *What makes the Division Engr look so happy this morning?*
Asst Engr - *The General Manager has just allowed him $600 to go ahead and build that new $8000 extension to round house*

Tapeman - *As tomorrow is a holiday can I have a vacation.?*
Asst. Engr - *Yes, from five oclock tonight untill eight oclock tomorrow morning*

He was ONCE.

R.R. Magnate - *So you think that you can support my daughter in the same manner in which she has been used too.*
Poor Engineer - *Why er-er-yes, wern't you an engineer yourself, once.?*



INSURANCE VALUE OF WATERPROOFING.*

By Myron H. Lewis, C. E.

I take up the subject of waterproofing advisedly because in the last few years we have often heard that waterproofing is unnecessary. While engineers often tell us that no waterproofing is necessary in concrete structures, the opinion is prevalent among the public at large that concrete buildings are damp and, being damp, are necessarily unwholesome, and you who are familiar with the concrete industry know that it is theoretically possible to so grade and blend the materials of the concrete as to obtain a watertight product.

But the consumer of concrete who has to foot the bill knows that although water-tight concrete is within the realm of possibility, it is not often in the realm of reality, and the number of examples of leaky structures due to one cause or another is altogether too large. The belief that concrete buildings are damp has taken firm root in the public mind and not without foundation, and an opinion once so rooted is difficult to eradicate. If there is one thing that has hurt the concrete industry more than anything else it is this impression in the mind of the public, which, unfortunately, is only too much justified by experience.

What does it avail us to assert that concrete can be made watertight if properly handled, when we know that perhaps fifty waterproofing concerns all over the country are engaged all the time in remedying dampness and leakage in concrete structures which, theoretically, should have been made waterproof but which, practically, have been found not so.

I may mention an instance of an important hotel building not very distant that was built about five years ago, and proved so leaky that for a year or two it could not be used. And an example of this kind, where every one who runs may read, does more to hurt the concrete industry than a thousand arguments that concrete can be made watertight. The expense incurred in order to attain watertightness after the construction has been finished is a hundred times greater than what it would have been in the first place; and this is nearly always so in waterproofing. We may almost call it an axiom of the industry. The loss of perhaps $2,000 in rentals would have paid for the waterproofing five times over and the expenditure of two or three cents per square foot during its construction would have rendered it immune for five years.

Those who argue that waterproofing is not necessary usually base their conclusions on their own experience or rather capabilities using the most careful methods, with strict supervision of every detail of the proportioning, mixing, and laying of the concrete; and the results obtained under such conditions are model and are the best obtainable, both as to density and impermeability. But for every one such perfect job, one hundred others turn out anything but model, and to maintain that waterproofing is not necessary because perhaps one job in one hundred turns out right, is certainly not justifiable position for the concrete men to take.

While admitting that it is possible to secure waterproof concrete by proper proportioning and handling of the material, *the large number of leaky structures throughout the country makes waterproofing of structures advisable as a matter of precaution and insurance*, particularly in structures below ground water or tide-water level.

It would be a difficult matter to estimate the tremendous annual loss caused by discoloration, disfigurement, and unsanitary and other objectionable conditions due to the injurious action of water on concrete and stone structures and structural materials. But just because water works slowly it works none the less surely, and I believe that the use of any method or material which will retard even for a limited period the injurious action of the water is justified on the basis of insurance.

I wish to call special attention to the waterproofing of sewers. This question has received hardly any consideration at all from sewer engineers, although it is one of greatest importance.

Mr. George T. Hammond, designing engineer of the Sewer Department, City of Brooklyn, has collected some valuable facts on the infiltration of ground water into sewers, showing conclusively the possibility of lower maintenance costs if the sewers were properly waterproofed, and from an insurance point of view, the cost of the waterproofing is almost negligible.

It is also generally agreed upon that watertight concrete is the only solution for the prevention of disintegration of concrete by sewage, sewer gases, alkali, and other corosive chemicals.

There are many methods of waterproofing on the market. There are many successful methods, but there are no cure-alls. Do not take any man's word who tells you that his material will waterproof any condition. The whole secret of successful waterproofing lies in selecting the method and material suitable for the condition at hand. Many of the standard materials will give good results if intelligently handled.

There are many cases where neither the "integral" method nor the "membrane" method will meet the conditions. Take, for instance, the preservation of beautiful stone monuments or decorative stone in process of decay, the disfigurement of buildings by efflorescence.

Some time ago I had the pleasure of reading a paper before a well-known technical society and in the discussion which followed a number of engineers present described various troubles they were involved in by neglecting to take the precaution of waterproofing their concrete which, theoretically, should have been watertight in itself, but which, practically, proved leaky and involved costly outlays for remedying the trouble.

These observations may be continued indefinitely, and sufficient evidence can be produced to convince the most skeptical that waterproofing of structures is a precaution which should always be provided for in any concrete structure intended for habitancy, and where leakage is in any way objectionable.

During the past few years a number of committees of technical societies have been condemning the waterproofing industry and, in my opinion, very unjustly. There are so many conditions to be considered that I cannot agree with the statements that waterproofing materials have been found of doubtful value. Many cases have not been covered by the committee work and broad statements of condemnation are misleading. Buildings which have been erected five, ten, or more years are often found leaky and damp. These must be made watertight and waterproofing materials must be employed for the purpose. When a broad statement is made that all such materials are of doubtful value, the consumer is induced to believe that his difficulties cannot be remedied, and that is certainly not so. These committees seem to be imbued with the idea that waterproofing should last forever and unless it does so it is worthless. I contend that we should expect only a reasonable length of life, consistent with first cost and cost to replace. A great many tests have been made during the last few years on various waterproofing materials. It is of great importance to know the results of these tests, but in addition to these results we must also get in touch with the consumer, and obtain information from the school of practical experience, as well, before we can pass final judgment as to the adequacy or inadequacy of any particular materials.

*From a paper given before the American Society of Engineering Contractors.

SHALLOW FLOORS FOR RAILWAY BRIDGES.*

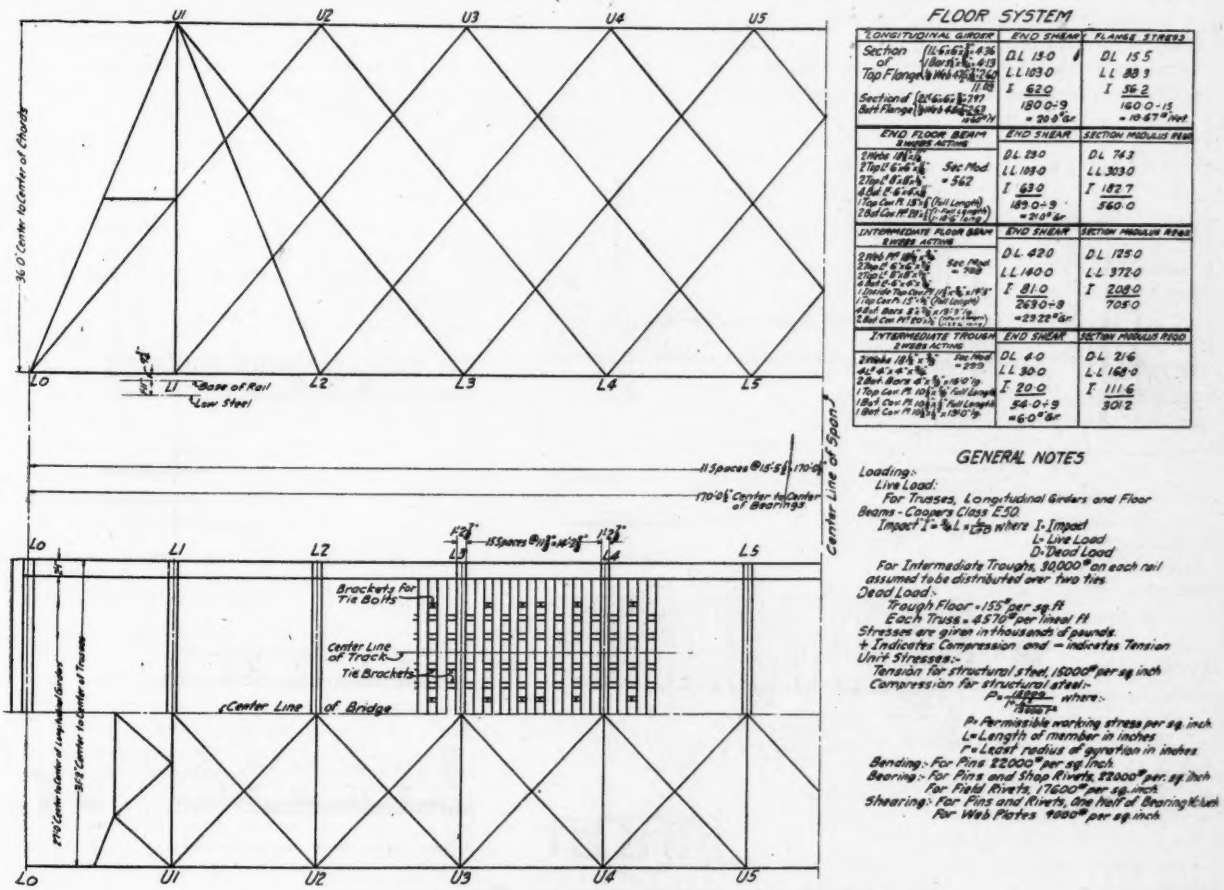
O. F. Dalstrom.

In railroad bridges of the through type, designed for crossings where local conditions do not govern the depth of the floor system, that depth is determined by sections that give the greatest economy of material consistent with simplicity of construction and facility of erection.

The floor beam usually determines the depth of floor in designs of open floor through bridges, whether truss or plate girder type. The term "depth of floor" will be used throughout this discussion to indicate the distance from base of rail to lowest steel of span. If considerations governing the design of the trusses produce panels of considerable length, the stringers, instead of the floors beams, may determine the depth of floor. A single-track truss span of 350 to 400 ft., with trusses 18 ft. 6 in. or 19 ft. centers, may have panels over 30 ft. in length. In such a design the economical depth of the stringer would be about the same as that of the floor beam. In common practice the floor beam would still be made deeper than the stringer to obtain simple details of connection between these members.

But conditions of grade and requirements of clearance below the bridge may make it necessary, in a measure, to disregard economy of material and simplicity of construction and erection to obtain designs that will meet all the requirements in special cases. Difficult conditions of grade and under clearance, necessitating extreme shallowness of floor, are frequently encountered in crossings over streets and over other railroads; and the type best adapted to any particular crossing must be determined by a careful study of the local conditions.

A crossing over another railroad usually means grades carried up above the normal grade of the line, with a through bridge over the railroad at the apex of the grades. If the approach grades are long and heavy, the slightest reduction in the depth of the floor of the bridge means an appreciable reduction in the cost of the approaches. And—what may be of greater significance than the reduction of the cost of bridge and approaches—it means the reduction of grades that would be costly and otherwise objectionable, or practically impossible, from the standpoint of operation, where local conditions determine limit of running out of the grade.


U1
U2
U3
U4
U5
L0
L1
L2
L3
L4
L5
36'0" Center to Center of Chords
Base of Rail
Low Steel
11 Spaces @ 15'5" = 170'0"
170'0" Center to Center of Bearings
Center Line of Span
Brackets for Tie Bolts
Center Line of Track
Tie Brackets
Center Line of Bridge
21'0" Center to Center of Longitudinal Girders
35'3" Center to Center of Trusses
FLOOR SYSTEM
GENERAL NOTES
Loading:-
Live Load:
For Trusses, Longitudinal Girders and Floor Beams - Coopers Class E50
Impact I = %L = 50 where I = Impact, L = Live Load, D = Dead Load
For Intermediate Troughs, 30000# on each rail assumed to be distributed over two ties.
Dead Load:-
Trough Floor = 155# per sq. ft.
Each Truss = 4570# per lineal ft.
Stresses are given in thousands of pounds.
+ Indicates Compression and − indicates Tension
Unit Stresses:-
Tension for structural steel, 15000# per sq. inch
Compression for structural steel:-
P = 16000 − 70 l/r where:-
P = Permissible working stress per sq. inch
L = Length of member in inches
r = Least radius of gyration in inches
Bending:- For Pins 22000# per sq. inch
Bearing:- For Pins and Shop Rivets, 32000# per sq. inch
For Field Rivets, 17600# per sq. inch
Shearing:- For Pins and Rivets, One half of Bearing Value
For Web Plates 9900# per sq. inch

Standard 170-ft. Through Riveted Latticed Span, C. & N. W. Ry.

The files of the bridge department of the C. & N. W. Ry. contain the plans of a large number of bridges that have been designed to meet extreme conditions of clearance, grade, and curvature. A few of these designs have been selected, with special reference to shallowness of floor, as typical.

Fig. 1 shows the floor details in the design of a double track through truss bridge of 170 ft. span, in which the depth of floor is 1 ft. 11 in. This bridge is designed for Cooper's Class E-50 locomotive; or a concentration of 60,000-lb. on each of two axles spaced 6 ft. 0 in. center to center.

The floor is of trough construction, the troughs being placed perpendicular to the axis of the bridge. Each trough carries a tie under each track, as shown in Fig. 1 transverse section through troughs and floor beams; the tie is supported at four points on horizontal angles riveted to the tops of diaphragms extending between the webs of the troughs. In every alternate trough, except those adjacent to the floor beam, special diaphragms are provided near

*From a paper given before the Western Society of Engineers.

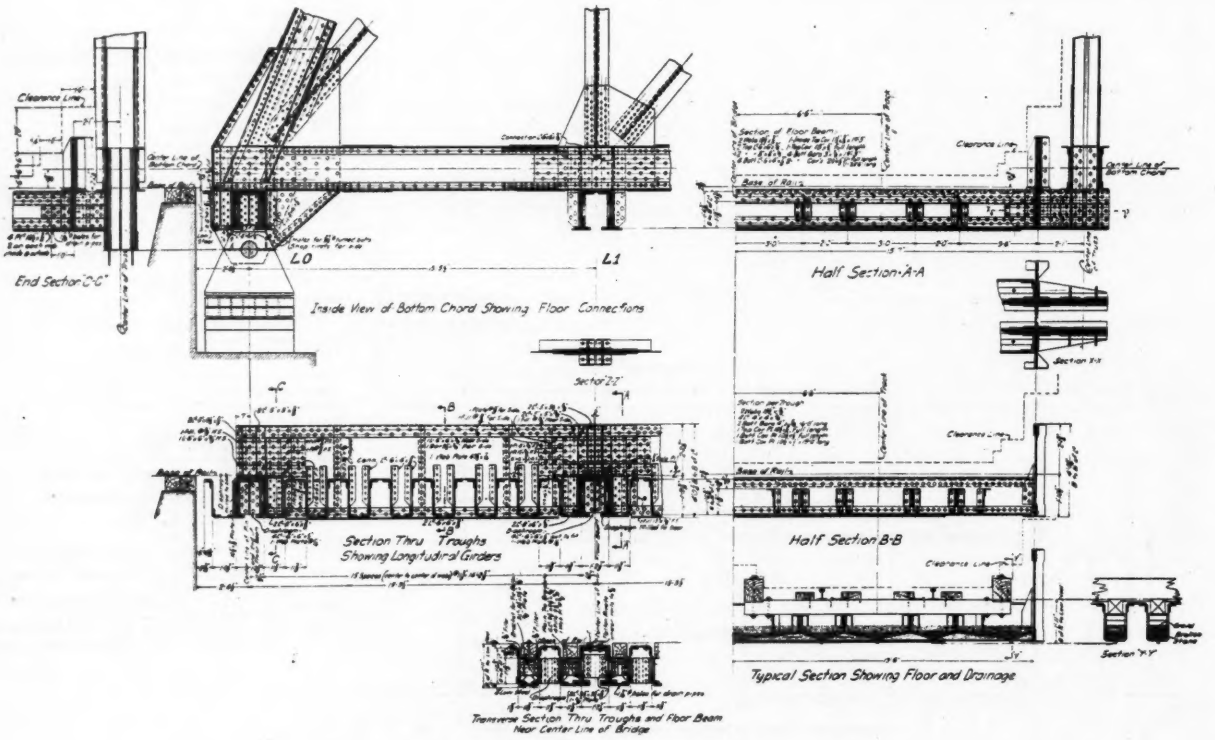
the ends of the ties. To these diaphragms the ties are anchored by bolts through the horizontal angles at the tops of the diaphragms, which are so located in the troughs that the bolts will be about 4 in.—a convenient working distance—inside the guard rail. The horizontal legs of the angles at the tops are turned toward the ends of the ties to make the bolts accessible after the ties are put in place. The tie bolt diaphragms are omitted in the troughs adjacent to the floor beams, as they would interfere with the driving of the field rivets at the ends of these troughs.

The troughs (Half-Section, B-B) are carried by longitudinal girders which are parallel to the trusses, and placed at a sufficient distance from the lower chord to permit ready inspection of chord and girder. The longitudinal girders are carried by the floor beams (Half-Section A-A), which are designed to receive the entire panel load and transmit it to the truss.

flattening the rivets under the rail and allowing a clearance of 1 in. from the base of rail to the tops of the flattened rivet heads, a satisfactory section is worked out with a depth of floor of 1 ft. 11 in.

It will be noted that the material in the floor beam and trough sections is not disposed symmetrically with reference to a horizontal line at the middle of the section. In order to obtain the most effective distribution of material, the neutral axis is maintained at the middle of the section. The metal is increased on the tension (lower) side to make up for the reduction of section by rivet holes, no allowance for reduction of section by rivet holes being necessary on the compression (upper) side of the section.

The depth of the longitudinal girders is made considerably greater than economic considerations require for the section. This is done to obtain a good detail at the end bearing and at the connection to the floor beam.


End Section C-C
L0
L1
Inside View of Bottom Chord Showing Floor Connections
Section 2-2
Section Thru Troughs Showing Longitudinal Girders
Transverse Section Thru Troughs and Floor Beam Near Center Line of Bridge
Half Section A-A
Half Section B-B
Typical Section Showing Floor and Drainage

Floor Details, 170-ft. Span, C. & N. W. Ry.

The troughs are designed to carry a concentration of 60,000 lb. on each track, each concentration distributed over two ties. This gives a load of 30,000 lb. on each of the two ties carried by the trough, or 60,000 lb. carried by the trough.

The floor beam is designed to carry the load from the intermediate troughs, concentrated at the bearings of the longitudinal girders, 2 ft. 1 in. from the center lines of the trusses; and, in addition, to carry its part of the load on the ties in the adjacent troughs.

The heavy load carried by the floor beam, together with its greater length, requires in this member a section considerably heavier than that of the troughs. The depth back to back of angles is made the same in floor beam and troughs, but the addition of flange material required to give the necessary section modulus in the floor beam, makes the extreme depth of this member somewhat greater than that of the trough sections. This extreme depth of floor beam determines the depth of floor for this type of bridge. By

The top flange of this girder is unsymmetrical, being composed of a plate and angle, the angle placed with its face against the web, the horizontal leg projecting over the top of the web and outward from the track. This detail of the top flange is to gain an additional horizontal clearance, as at this point the structure approaches nearer to the clearance diagram than at any other place except at the end post, where the edge of the cover plate is coincident with the extreme vertical line of the clearance diagram. An advantage in erection is also obtained by this detail of top flange section, as it permits setting the trough sections in place on the bottom flanges of the girders, with only a very slight displacement of the girders from their permanent position.

To further facilitate erection of the troughs, the stiffeners are omitted from the inner side of the longitudinal girder. The end connection angles of the troughs, which are held riveted to the web of the girders, are placed high enough

so that the tie bolt diaphragms near the ends of the troughs will not interfere with the driving of the field rivets at the ends of the troughs in which the tie bolt diaphragms occur.

The troughs are drained through 1 in. gas pipes fitted into holes in their bottoms and projecting slightly below the trough to form a drip. This projection of the drain pipes must not extend below the line of low steel determined by the river heads on the under side of the extreme cover plate of the bottom of the floor beam. The upper ends of the drain pipes are threaded into washers to hold them in place.

The lower part of the troughs is filled with asphalt mastic, the surface sloping toward the drain pipes and flashed over the washers at the upper ends of the pipes. A layer of broken stone covered with gravel is spread over the mastic for a protection.

The deflection of this floor under a maximum load is considerably greater than that of floors designed for depths determined by economical sections. Under maximum load the theoretical deflection at the center of the floor beam is 0.65 in.

The erection of truss bridges of the open trough floor type requires a special order of work in riveting owing to the longitudinal girders being located so close to the trusses. After the girders have been placed in position, no riveting can be done on the inside of the lower chord opposite the girder. On this account all riveting in the trusses below the level of the tops of the girders must be done before the girders go into place, which means that all lower chord splices, floor beam connections to trusses, and web member connections to gusset plates, up to the level of the tops of the girders, must be riveted before placing girders and trough sections. There is no interference from the girder in driving the rivets on the outside of the truss, but these rivets, up to the level of the tops of the girders, should be driven at the same time that the riveting on the opposite side of the truss is done.

In the development of a shallow floor for double track bridges, the first efforts were directed toward obtaining an open floor design, with stringers beneath the track, transmitting the load directly to the floor beam. The excessive bending moment in the floor beam, resulting from this arrangement, made it impracticable to design a floor beam that would come within the required limits of depth of floor.

Following this, a trough floor type was designed, differing from the one shown on Fig. 1 in that it had no longitudinal girders to carry the troughs. Instead, the troughs were extended to the trusses and connected to the bottom chord in the same manner that the floor beam on Plate I is connected to the chord at the panel point. The bottom chord was designed to act as a girder, to carry the panel loads to the panel points.

This design brought the depth of floor within the required limits, but made the troughs excessively heavy. The bottom chord was necessarily made deep and heavy, since it had to act as a beam for the floor troughs at the same time that it was doing duty as a tension member in the truss.

The next step was the introduction of the longitudinal girder. This was placed as close to the track as the clearance diagram would permit, to reduce as far as possible the bending moment, and thereby the sections, of the floor troughs. The introduction of the longitudinal girder changed the bottom chord from a combined beam and tension member to a simple tension member, and eliminated from it the objectionable secondary stresses produced by the vertical loads applied at the trough connections.

Below are given a few figures for the comparison of a 170 ft. double-track span of the above type, and a double-track span of the same length, with the usual open floor construction, in which the floor beam and stringer sections are determined by the economical depth.

	Shallow Trough Floor Type.	Deep Floor Type.
Depth of floor	1 ft. 11 in.	4 ft. 9 in.
Weight of floor system per lineal foot of bridge	5,000-lb.	1,700-lb.
Weight of trusses and bracing, per lineal foot of bridge	3,500-lb.	3,250-lb.
Weight of 170-ft. span, complete	1,496,000-lb.	900,000-lb.
Total cost of span, f. o. b. cars at bridge company's plant, at $0.025 per lb.	$37,400.00	$22,500.00

Difference, $14,900.00 = 66.2 per cent of deep floor type.

As the depth of floor is increased, the weight diminishes rapidly. At 2 ft. 4¼ in. depth, the weight is 4,100-lbs. per lineal foot of bridge. Further increase of depth would show a corresponding decrease in weight until the minimum thickness of material in sections is reached.

Unit prices in bids submitted by bridge companies for the fabrication of material for the shallow trough floor type, have been found to run about the same as those submitted at the same time for open floor truss bridges. On this basis, a comparison of the two types of the span selected show that the shallow floor type would cost, f. o. b. cars at bridge company's plant, about 66 per cent more than the deep floor type.

The cost per ton for erecting would be about the same for both types. The number of field rivets per ton is somewhat less in the shallow floor type than in the other type; but an allowance, for which no figures are at present available, must be made for the order of procedure in riveting, which requires that part of the riveting be done before all the material in the bridge is assembled, and for the additional falsework and blocking that is necessary under the floor system to provide for the uninterrupted movement of trains.

The comparison of costs of the two types erected would show about the same relation as that of the costs of fabrication.

The range of application of floors of this type in double-track truss bridges would cover depths of floor of about 3 ft. and under, if the panel lengths do not exceed 15 ft. With a depth of floor over 3 ft. an open floor bridge is practicable and would be more economical.

For double-track through girder bridges, where panel lengths can be varied as desired, the application would be limited to about 2 ft. 6 in. depth of floor.

Hydraulic grading is being done on an approach to a new bridge of the Southern Pacific Railroad at Sacramento, Cal., where the grade has to be raised 4 or 5 ft. A 20-in. pipe is used, the material being furnished by a hydraulic dredge. About 15 men are employed laying sand bags along the sides of the approach to retain the wet fill, which is carried about 1,200 ft. beyond the outlet of the delivery pipe.

On the outskirts of Sacramento, Cal., the Southern Pacific is erecting a steel bridge across the Sacramento River that contains the heaviest swing span of any bridge in the world. It is 400 ft. long and weighs 6,300,000 lbs. Only two steel bridges in the world have swing spans that exceed this one in length. One is across the Willamette River and is part of the Spokane, Portland & Seattle system. Its weight, however, is 5,400,000 lbs., 900,000 less than that of the Sacramento River bridge. The Omaha Terminal Co. operates a large steel bridge across the Missouri River that has a swing span 520 ft. long, but the steel is of much lighter construction, the weight being only 5,100,000 lbs. The Sacramento River bridge will contain not only two tracks for the trains but a concrete wagon and automobile road.

TIE TREATING PLANT AT ALBUQUERQUE, N. M.

By C. W. Wiggett, Supt. Tie Treating Plant.

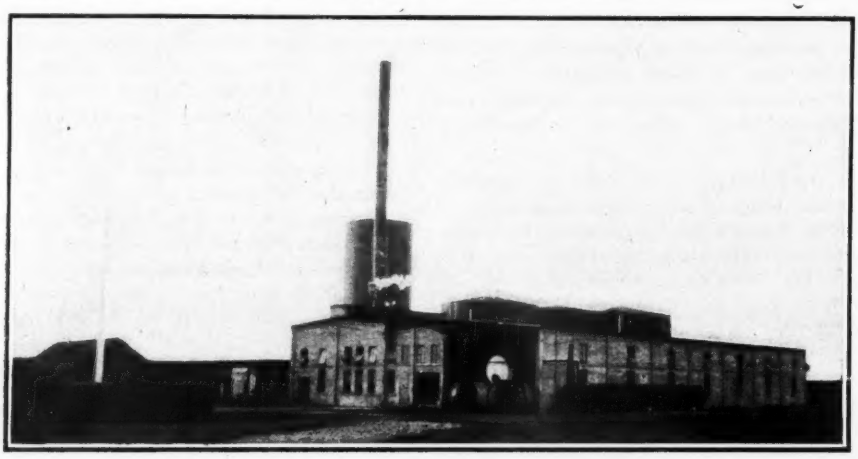
The Albuquerque plant has a yearly capacity equivalent to handling 1,250,000 ties. The tracks, material yard and buildings occupy seventy acres of ground. All buildings used for housing the equipment necessary for the treating operations are made of reinforced concrete. The boiler-room is 36 by 36 ft. in size, and contains three 100-horsepower tubular boilers, a feed pump, a water heater and an Underwriters fire pump. The pumphouse is 24x56 ft. All valves regulating the flow of preservatives from the tanks to the cylinders are located therein, as well as gages recording pressures, temperatures, etc., an air compressor, a dynamo and pressure and vacuum pumps. The cylinder house is 28x158 ft. and contains two impregnating cylinders 6 ft. in diameter by 132 ft. in length; and one pressure cylinder (elevated) 6 ft. in diameter by 109 ft. in length. All equipment is of the most modern type and is suitable for using the full cell, the Rueping or the boiling processes.

Oil storage equipment consists of three steel tanks with a capacity aggregating 450,000 gals. One hundred and sixty 24-in. gage tramcars are in service conveying material to and from the retorts. They are handled from the main yard to the storage tracks with a switch engine, and from there by means of a hoisting engine and cable.

Ties received for treatment are shipped in from Flagstaff, Ariz., from Thoreau, N. M., from the vicinity of Las Vegas, N. M., and from the Santa Barbara grant near Taos, N. M.

Inasmuch as the Santa Barbara ties do not come through the regular channel (Santa Fe all the way), it might be of interest to know that these ties are floated some 90 miles down the Rio Grande to Domingo, N. M. At this point they are loaded for the plant by means of two mechanical loaders, handling about 30 ties per minute. The floating helps materially in the treatment, as it requires less time and pressure to impregnate the ties, due to the action of the water freeing the wood cells of a certain amount of albumen and starch.

Native pine and spruce lumber, as well as piling, is shipped from Las Vegas. A small amount of Texas pine also is handled at the plant.

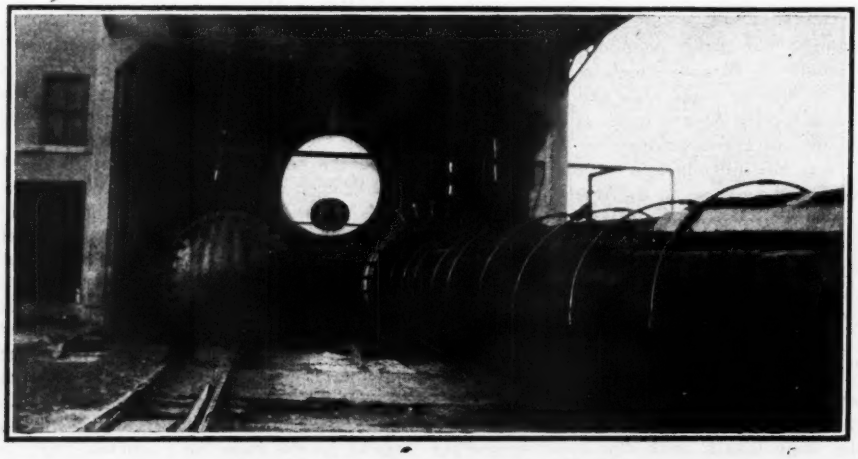


Tie Treating Plant at Albuquerque, N. M., A. T. & S. F. R. R.

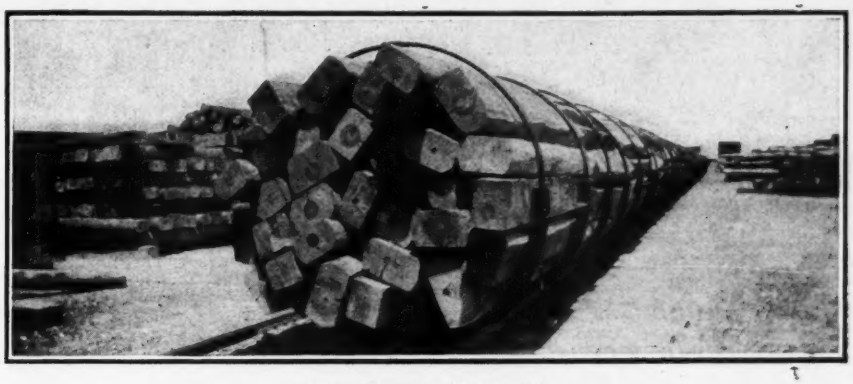
On receipt of material at the plant it is piled in the storage yard from three to four months for proper seasoning previous to the treating operations.

The climatic conditions and species of timber to be treated govern the process and method of handling. Results obtained in one section or locality with a certain class of wood are not a criterion to go by in another, where conditions are not the same. It is a known fact that wood entirely submerged, or kept dry, lasts indefinitely. The most favorable condition for decay is where the timber is exposed to moisture, heat and air. The defense lies in the proper treatment to eliminate the moisture and the air or to inject an antiseptic to prevent the propagation of fungi.

The New Mexico and Arizona pine absorbs fluids very readily in most cases, and allows the use of Bakersfield crude oil, having an asphaltum basis as the preservative.



Ties Coming Out of the Treating Cylinder.



Ties Ready for Treatment.

This oil, when once properly injected into the timber, forms a plug impermeable to air and moisture. The cells in the heart wood being lifeless, it scarcely is possible to get this portion of the tie into condition to absorb any preservative without injuring the fibers, excepting when the heart is at the surface, in direct contact with the hot oils. In such cases oil will assimilate and displace a certain amount of the resins and starches.

The hewn native pine ties have a ring of sap wood encircling the heart and are treated with the California oil by the full cell process, which fills the cells of the sap wood, forming a permanent plug against air and moisture. Approximately six gallons of oil is absorbed per tie.

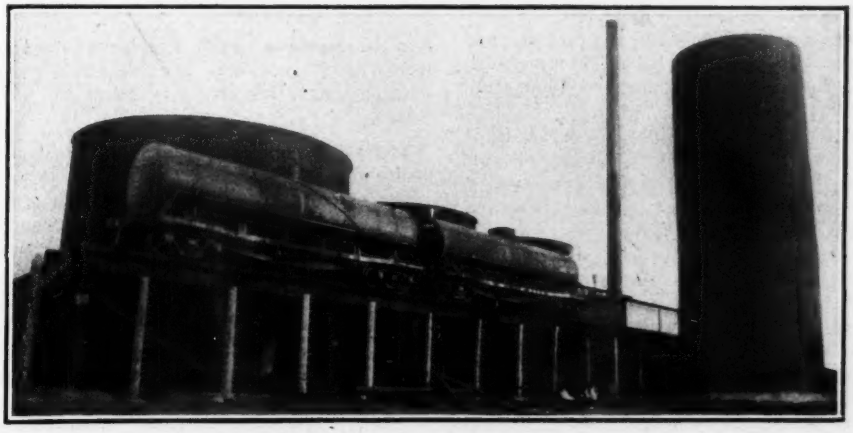
Sawed ties are made from much larger timber, the wood of which is more dense and composed of a greater percentage of heart. Such ties are treated with a mixture of Bakersfield oil and creosote, in the proportion of 70 and 30 per cent. On account of the oil being quite viscid or thick the close grain wood does not absorb the oil readily, but when thinned with creosote, the oil finds its way into the wood cells. The creosote being an antiseptic of great power, and the Bakersfield oil having the properties of excluding the aid and moisture, this mixture must appeal to one as an ideal treatment.

The operation of the full cell process, which is used with the oil mixture, is as follows: Cars loaded with ties are run into cylinders and the doors are closed. Preservatives then are introduced, at 160 degs. Fahr., and the temperature gradually is increased to 190 degs. by means of steam coils, increasing the fluidity of the oil as well as expanding the wood cells. After the maximum temperature is reached care must be taken to see that the thermometer does not drop below this point. The cylinders are equipped with recording thermometers, giving a constant record of the temperature and the pressure at all stages of the operation. While the temperature is being raised, the pressure also is being pumped up gradually to its maximum, 200 lbs., and held at this point from one and one-half to five hours. The oil then is forced back into the storage tanks and vacuum drawn for one hour, to dry the ties and to avoid any waste in the yard from drip.

With the New Mexico red spruce we have a different species with which to deal. The growth is very slow and the wood is dense, with scarcely any sap wood or zone where the cells are active. A treatment with the oil or mixture scarcely would enter the wood cells, so creosote, which is more fluid, is used for the antiseptic. Owing to the high cost of creosote, which is imported from Germany, a full cell treatment is prohibitive for crossties, but fortunately we have in the Rueping process a means of distributing the creosote uniformly, keeping the cost within bounds in comparison with the other processes.

The Rueping process is what would be termed an empty cell treatment, as the wood cells first are filled with air under pressure, then the creosote is introduced and forced into the tie at a greater pressure, driving the air to the heart of the wood, where it forms a cushion. When the cylinder is relieved of the creosote the air expands, forcing the surplus oil out of the cells, leaving them painted instead of full. The initial air pressure may be so regulated that one may obtain almost any result, that is within a range up from three pounds to the cubic foot.

The treating operation for spruce ties, with four and one-half pounds of creosote to the cubic foot, or two gallons to a tie of four cubic feet, is as follows: Air is introduced into the impregnating cylinder containing the ties until eighty pounds is registered. The same pressure is applied to the elevated or pressure cylinder holding the creosote, the pres-

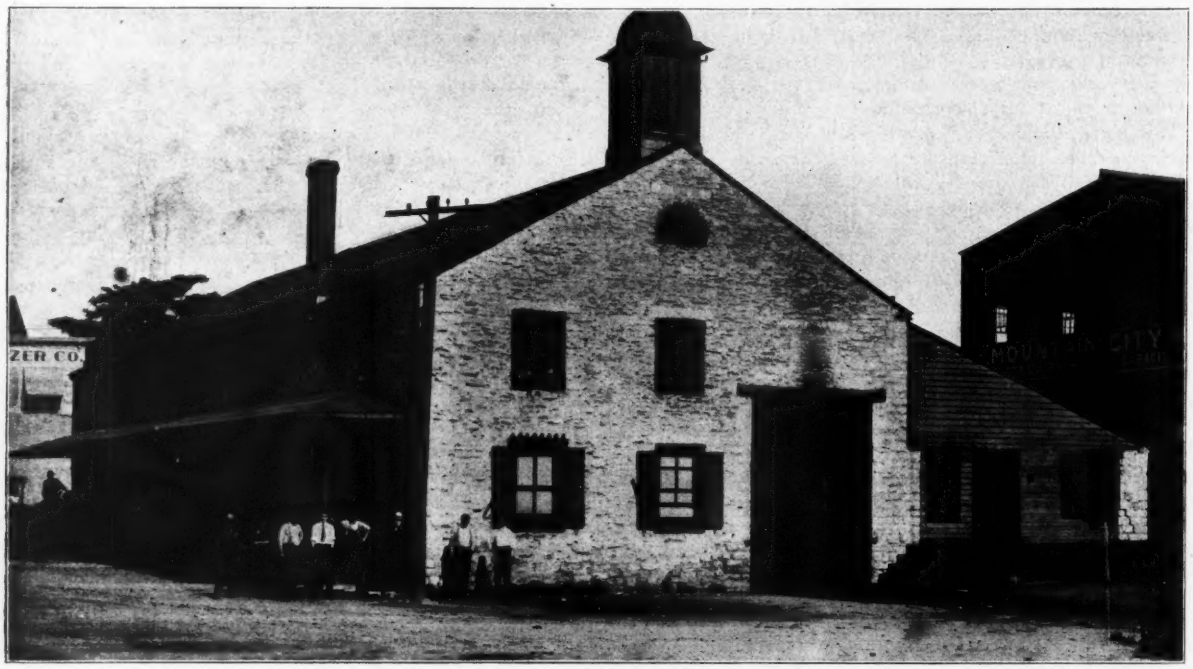


Oil Trestle.

sure being equalized in the cylinder containing the antiseptic and the cylinder containing the ties. Th creosote then is run into the impregnating cylinder by gravity, and the pressure is pumped up to two hundred pounds and held there from four to six hours. The creosote, under pressure, drives the initial air to the heart of the tie, where it forms a cushion equal to the outside pressure, or two hundred pounds. The oil then is dropped to underground tanks and a vacuum drawn, which assists the egress of the air as the cells are emptied, leaving the walls painted with the antiseptic. If a greater or smaller amount of the preservative is required the initial air pressure should be increased or decreased accordingly.—*Santa Fe Employes' Magazine.*

FREIGHT STATION, FREDERICK, MD.

The Baltimore & Ohio R. R. recently awarded a contract for extensive improvements at Frederick, Md., which involved the expenditure of $50,000, to Edward Brady & Sons, of Baltimore. Work was commenced on it the middle of last June. The plan of improvement provides a thoroughly modern layout which will give Frederick freight facilities equal to any city of its size on the Baltimore & Ohio. The new terminal will be a marked improvement over the present freight facilities at Frederick, which have become inadequate for the city's business requirements and commercial development.



Old Style Freight Station at Fredericks, Md., B. & O. R. R.

The plans provide for a modern freight house 200 ft. in length and 40 ft. in width, covered with corrugated iron, which will be equipped with rolling steel doors, making 95 per cent of the sides available for door opening. The new building will be located just north of the present freight house, which will be removed and which is said to be the first railroad freight station built in the world. At the Carroll street or west end of the building, a commodious office will be supplied for the agent, with booths for check clerks. Standard scales will be installed for weighing and wagon scales will be located next to Carroll street. Two paved driveways will be constructed, one on each side of the building, one of which will be 600 ft. long by 40 ft. wide and the other 500 ft. long by 45 ft. wide. A modern drainage system will be installed throughout. The new terminal will have a capacity of 140 cars.

TESTS OF CEMENT GUN MORTARS.

A number of comparative tests have been made on cement gun and hand made mortars by Westinghouse, Church, Kerr & Co. The hand work was carefully done under practically laboratory methods by an expert union plasterer. Special care was exercised to make these hand specimens as good as possible and they cannot be compared with the ordinary commercial hand work done under contract. The gun work, on the other hand, being done by a machine, would show the same in commercial practice as it did in the laboratory tests, and conclusions as given in their report are as follows:

In all of the tests made the product of the cement gun showed superior to good hand made products of the same kind. The degree of superiority varied between wide limits.

In tensile strength the gun work excelled hand work in every case by amounts ranging from 20 per cent to 26 per cent.

In compressive strength the excellence of the gun work was even more marked, ranging from 20 per cent to 72 per cent better than hand work.

In the matter of surface permeability the gun work absorbed from 7/10 (70 per cent) down to 1/20 (5 per cent) as much water per hour per unit of area as the similar hand made surfaces.

As regards absorption of water the hand made mortars took up from 1.4 to 5.3 times as much as the gun made mortars.

The percentage of voids of the gun made product ranged from 52 per cent to 75 per cent of that of the hand made product.

The Adhesion of the Gun applied mortars was on an average 27 per cent better than that of the hand work.

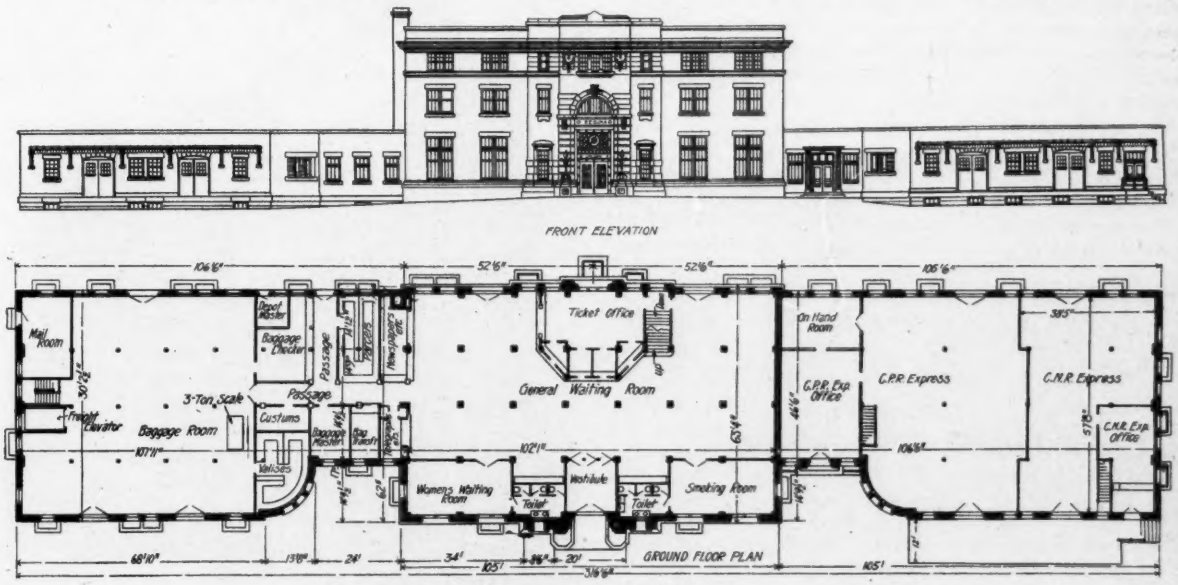
The American Wood Preservers Association has hit upon the plan of sending out a monthly bulletin, with mention of all items of possible interest to Wood Preservers appearing in the technical press. The first of these bulletins was issued in January, 1912, and contains mention of a dozen articles, giving the name, approximate length, and other particulars.

REGINA UNION DEPOT, CANADIAN PACIFIC RAILWAY.

The Regina Union depot is being built for the joint use of the Canadian Pacific and Canadian Northern Railways. The design and details were made in the office of the chief engineer of the Canadian Pacific at Winnipeg. The work is being carried out under the supervision of the divisional engineer at Moose Jaw. The J. McDarmiad Co., of Winnipeg, has the contract for the work. The station will be opened for the use of the general public in 1912.

The main building is fireproof throughout and the wings are of slow burning construction. The main building is reinforced concrete frame construction, the foundations being also reinforced. The Turner system of reinforcing is being used. The ground floor of the main building is designed to carry a live load of 175 pounds per square ft., and the first and seconds floors 75 pounds per square ft. The wings are designed to carry 200 pounds live load per square ft. The building has been designed so that an additional story can be added over the main building, if required for offices.

The main portion of the structure is 105 ft. long and 64 ft. wide. The east wing is 105 ft. long and the west wing is 107 ft. long. The cost of the whole structure including track work, platforms, fittings, etc., will be $200,000. The structure is being built of Bedford stone in the renaissance style. A special feature has been made of the deep stone reveals of the door and window opnings.



Plan and Elevation of the Regina Union Station, Canadian Northern Ry.

The principal entrance is in the center of the main building and faces Railway street; a subway is provided under the tracks at the east end of the building on Broad street. The track side has two entrances, one on each side of the ticket office, which is placed centrally in the general waiting room opposite the main entrance.

A steel and glass marquise suspended on heavy iron chains from lions heads bolted through the wall, runs the entire length of the main building outside the general waiting room on the track side. This marquise has ornamental copper cresting and shields, and projects 12 ft. from face of stonework over the train platform. Similar protection is provided outside the baggage and express department both on the front and track sides, but the supports consist of steel trusses bolted into the walls. A clock chamber is provided over the main entrance with self illuminating clock dials showing from the front of the building and also in the general waiting room. The vestibule and waiting room staircase and corridors are designed in the French renaissance style.

Entry is made from the main entrance through the vestibule to general waiting room by folding doors. This room is made one of the features of the building. In size it is 44 ft. wide and 102 ft. long, and has a height of 19 ft. A marble terazza floor with dark marble border is provided around the room and between piers. The walls of the general waiting room are decorated with a panelled oak moulding 10 ft. high, supported on a verdantique marble base. The central piers and wall pilasters are finished in plaster supported on verdantique marble bases. The plaster caps of these piers are enriched with ornamental plaster shields. The piers and pilasters carry the plaster freize, architraves and modillion cornice under the ceiling. The light well, which is between the ticket office and vestibule, is finished in oak to match the interior trim of the general waiting room. The light shaft is carried through the first and second floors and is finished on the corridor side with a brass handrail. This light shaft also serves to ventilate and light the offices on the inside of the building.

The booking office is 9 ft. high and the front is octagonal in plan; it is provided with two ticket cages, each 7x8 ft., with interlaced wire partitions and appropriate fittings. There are a number of counters, including information and ticket counters, with metal grills over them. Special fittings are provided at the back of counters to suit the requirements of the ticket agent, and a ticket room is provided in the basement for the storage of tickets.

A steel and marble staircase is provided from the general waiting room at the side of the ticket office to give access to the offices on the first and second floors. This staircase leads to the mezzanine floor over the booking office (which is finished as a gallery, with terraza floor and iron railings) with plaster newells supporting ornamental electric light fittings. The staircase, from the gallery to the first and second floors, is provided with wrought iron ornamental shields and oak handrails.

Ornamental plaster shields and enrichments are designed over the entrances of the general waiting room and above the pilasters of the doors and windows. The panelling of the waiting room door and windows, counters, pilasters, etc., is white oak, finished with a dull surface. The space outside the baggage department is finished to match. All the plaster

work, with the ornamentation mentioned, is tinted to harmonize with oak finish and marble work, as is also the ceiling, the latter being a light buff.

The smoking and retiring rooms, toilets, news and telegraph offices are easy of access from the general waiting room. A 15 ft. space is provided at the west end in the baggage department to provide access to the counters of the parcels, baggage transfer and checking rooms, and there is a valise room at the rear of these. The baggage master's office is situated at the side of the checking room. An entrance from the platform is provided for the use of passengers. The telegraph department is placed at the west end of the general waiting room, where there are also two private telephone boxes. Opposite the telegraph department is the news agent's office with glass silent salesmen on both sides. Besides the accommodations mentioned above, the west wing has mail transfer and customs offices; the rest of the wing, including the basement, is for the storage of baggage. An Otis electric elevator is provided for handling baggage.

The east wing is occupied by the Dominion Express company and the Canadian Northern Express Co. The public entrances to these offices are from Railway street. The offices will be fitted up with quarter sawed oak counter fittings, and cages to suit the companies' requirements. The basement of this wing is used for storage purposes. The boiler room for heating the building is in the basement in the center of the main building.

The electrical work is done by the electrician of the Canadian Pacific, and all the wiring, fittings, etc., will be of the most up-to-date description. Lights are suspended from hanging chain pendants in the general waiting room, and are supported by brackets attached to wall pilasters and fittings in the gallery. Specially designed electric light standards will be provided over stone pedestals at the sides of the principal entrance. These will be finished to harmonize with the metal grillage at entrance. The first and second floors of the main building will be used for offices by the two railway companies, and will be subdivided to suit the requirements.

FORT GARRY HOTEL, WINNIPEG.

Adjacent to the ruins of that historic monument, "Old Fort Garry," memorable in the early history of Canada, is to be erected "The Fort Garry" Hotel, truly representative of greater Winnipeg—an edifice to rank with the world's finest hotels, embodying in its construction advanced scientific and architectural ideals. The location is in the very heart of Winnipeg, toward which all lines of traffic converge. It is readily accessible to the railroads and electric car lines, and is within a minute's walk of the new terminal station of the Grand Trunk Pacific and Great Northern.

The Fort Garry is being constructed by the Grand Trunk Pacific Development Co., of the finest Canadian granite and buff limestone, in the style of the old French chateaus of Normandy and Touraine. The building will be fourteen stories high, and is to have approximately 350 rooms. All rooms are to have private baths, and are to be equipped with approved modern appointments. The comfort and welfare of guests has been carefully considered in the preparation of the plans and interior arrangements, which are such as to promote homelike comfort. Every detail of construction and furnishing has been worked out in accord with this idea and would seem to assure the largest measure of personal enjoyment and restfulness to guests.

The main entrance of the hotel faces on Winnipeg's most beautiful thoroughfare, Broadway, and opens upon a spacious and refinely decorated rotunda. The central feature of the main floor is the circular tea room, unbroken by columns, lofty in height, and lighted by broad windows and circular domed ceiling.

The mezzanine gallery is a story midway between the office floor and the parlors. It is reached by a broad marble staircase from the main entrance lobby and is finished and decorated in white and delicate shades of color. It overlooks the entrance lobby, dining room, cafe and tea room, and will be used as ladies' parlor, waiting room and library. It commands a view of those portions of the house where the most life occurs, and yet at the same time affords a quiet sense of retirement.

The ball room, banquet hall and foyer have been located on the seventh floor. These rooms are the richest of the public rooms, and have been so arranged with separate kitchen service, reception and dressing rooms, as to in no way interfere with the privileges of the guests of the hotel. The ball room is designed in the Louis Quatorze period and is one of the most striking of its kind in Canada.

Grand Trunk Pacific Hotel, Winnipeg, Man.

Immediately in front of the foyer of the ball room and banquet hall is a beautiful loggia, some 30 ft. in width, forming a promenade for the entire width of the building and commanding a view of the entire city of Winnipeg. The building as a whole will form an example of what modern science can do in the elimination of fire risk. Every girder, beam and rafter is to be of non-expansive steel, every partition of terra cotta, every floor of marble, tile or cement, and the stairways of iron. It is to be absolutely fireproof, and while every precaution has been taken to insure absolute protection to life and property, an equal measure of attention has been devoted to its sanitation and the safeguarding of health. The bath rooms are to be models of sanitation and simplicity, and are to be equipped with porcelain fittings and finished in exquisite tile work. They are comfortable in size, and are so placed as to be in direct communication with every room in the hotel.

Notable features of the residential portion of the Fort Garry are the several state and family apartments on every

floor from the second to the seventh. These consist of an ante-room, drawing and dining rooms and the necessary bedrooms, each suite having its own private hall and bath rooms. The remaining rooms on these floors and the rooms of the upper floors from the seventh to eleventh are divided into rooms and suites. These are small only by comparison with the spacious state apartments already described; 70 per cent. of these are outside rooms, lighted and ventilated with adequate window areas. No treatment of the interior which effects garishness will be permitted. The color tones are to be in harmony and the furniture is to be made to order from special design.

There is not to be a dark or uninviting room in the entire building, and comfort and spaciousness have not been sacrificed to secure a maximum of accommodation. Large closets have been provided in every room, and in the suites there are commodious clothes presses equipped throughout with every modern device.

The architects for the Fort Garry Hotel are Ross & MacFarlane, of Montreal and Winnipeg, and the Geo. A. Fuller Co., Ltd., has the contract for the erection of the structure.

REPORT OF ACCIDENT ON THE LEHIGH VALLEY R. R. NEAR MANCHESTER, N. Y.

On August 25, 1911, under the direction of the Interstate Commerce Commission, its chief inspector of safety appliances, H. W. Belnap, and three assistant experts entered upon an investigation of an accident which occurred on that date on the line of the Lehigh Valley Railroad near Manchester, N. Y.

During the investigation owing to the disclosure of defects in the rail which were the apparent cause of the accident, the Commission asked the Department of Commerce and Labor, through its Bureau of Standards, to co-operate in an examination of the pieces of the defective rail.

Report of James E. Howard.*

A rail was fractured on the north side of the track on which the train was running, abreast a crossover, a part of the train was precipitated from the opposite side of the track, the south side, to the bed of the creek, Canandaigua Outlet, from the plate-girder bridge spanning the creek.

The fractured rail was several rail lengths east of Manchester Station, the bridge several lengths east of the fractured rail in question.

The fractured rail was a 90-pound American Society of Civil Engineers section, basic open-hearth steel, made by the Bethlehem Steel Co. It was an A rail from the ingot. The steel was made on specifications calling for carbon content between 0.70 and 0.80 per cent. This rail was laid October 21, 1910, in the east-bound track, where it eventually fractured. Frogs were changed about April 20, 1911, at which time this rail was shortened by cutting off 6 feet from its west end, reducing its length from 30 to 24 feet. Three new bolt holes for splice plates were drilled in the web at the time of cutting off.

This fractured rail exhibited two kinds of defects. It had a piped web, and in addition thereto it also displayed in the head a number of dark spots, which it should be said are light, silvery ones in certain fresh fractures. The surfaces of those spots are normal to the length of the rail. They have recently attracted attention, but no colloquial name has been given them.

The specifications under which this rail was rolled required not less than 20 per cent discard from the top of the ingot in order to secure sound steel. Notwithstanding this requirement, nor the mill, nor the track inspection, this rail got into the track, where it remained for a period of 10 months, until the time of this disaster. The specifications require shearing to continue if, after 20 per cent discard, the metal does not appear to be solid, until it does. If the shearsman could judge of the defect in the steel which, when rolled, caused this split web the entire length of the A rail, then that requirement of the specifications was not met. If, on the other hand, his opportunity is not adequate to allow of the discovery of such defective steel, then the requirement has a perfunctory character, so far as pertains to the rolling mill.

Whether the split web was in evidence as such on the hot sawed ends of the rail can not be definitely stated, since neither end was present when fragments of the rail were examined. The end which originally formed the west end of the rail has been cut off at the time of putting in the new frog, while the original east end had been cut off and removed since the time of the wreck. The split, however, was visible on the ends of the several fragments which were available and examined. The split was also visible in a new hole drilled through the web alongside of one of the holes understood to have been drilled through the web at the time of putting in the new frog.

Under direct compressive stress the web was very strong notwithstanding the presence of the split. A section of this rail 1 inch long sustained a load of compression applied on the running surface of a head of 75,420 pounds. This piece which was tested came from a fragment less than 2 feet distant from the west end of the rail, as it existed at the time of the wreck, and represented therefore an unfavorable part of the rail. It displayed some toughness and opened along the seam in the web before final rupture .

The views concerning the defects in the head which have reached the writer have attributed the cause of these so-called defects to some unidentified and unknown reason connected with the process of manufacture of the steel. Expert testimony taken before the coroner states that the dark spots in question "indicate a decided defect in mill practice, but can't say positively what may have caused it, but we can say that something in connection with the manufacture of that rail caused a separation of the metal at that point, constituting that defect," and more to the same effect.

The manufacturers of the steel clearly take the same view as expressed in the testimony before the coroner, since it is understood that the Bethlehem Steel Co. is at present engaged in a very energetic inquiry into the physical condition of their rails, but it may be said that their inquiry has up to the present time developed no information nor clue to the formation of these defects, nor have such defects been found in any of the new and unused rails of their current manufacture.

One prominent consumer seemed to entertain the thought that different ores had been used that for some occult reason refused to mix well metallurgically, resulting in the introduction of structurally defective zones in the steel. It will be recalled that not long ago, counted almost by months instead of years, Bessemer rails were in disfavor and a demand made for open-hearth metal, which resulted in the installation of a number of new open-hearth plants for rail making and the conversion of others.

It appears that fractured rails resulting from transverse fissures in the heads are not confined to the experience of one railroad. Their development is a matter of the utmost concern and introduces an element of danger in railway travel most menacing. From the number of fractures which are appearing within a limited territory the possibility of an epidemic of wrecks is not altogether a remote one.

*Engineer Physicist of the Department of Commerce and Labor.

The analysis gave the following composition of this material in the split in the web:

SiO_2.	Al_2O_3.*	CaO.	MgO.	Not determined.†
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
23.2	20.5	40.8	7.5	8.0

*Comprises Al_2O_3, Fe_2O_3, TiO_2, P_2O_5, Mn_3O_4.
†H_2O, CO_2, a little coal, perhaps SO_3 and alkalies.

From the above composition it is inferred that this slag-like material was rolled into the rail through the several passes down from the ingot, earlier coming from the ladle, and had its origin in the steel furnace.

There were a number of short fragments with ends very much battered and long fragments broken with less battered ends. The strength of the web, even with the split, was very great, as the test of a section 1 inch long showed. The heaviest wheel load is assumed to have been on the locomotives. It would seem to harmonize with the appearance of these short fragments to believe that the primitive fractures were caused by the locomotives; that one by one these short pieces were detached after some very severe pounding had been sustained; that the next in the order of events was the breaking of the longer pieces. Necessarily the spikes would in the meantime have been drawn more or less as the forward wheels of successive trucks struck these parts of the rails. The fissures existing in the head of the rail, as it is believed they did, and with loosened spikes would present a condition facilitating the further rupture of the rail in a brittle manner. It seems certain that no such resistance against the fracture of the rail was subsequently encountered by the train above that of the small fragments. The small fragments of the head being detached, as they were, from a middle part of the length of the rail, with a great display of resistance on their part against being detached from the web and base, called for a succession of heavy blows such as the locomotives would be capable of delivering rather than the coaches. It suggests that the destructiveness to the track was heightened by reason of there being two locomotives present.

When admitting steam to get the train under headway would seem a critical period in regard to overstraining the track, more so in the case of a double-header and long train than in the case of a short one. Momentarily, the forward engineer being the one naturally first to admit steam or to accelerate the speed of the train, the train resistance would tend to overturn the forward locomotive, pull it over backward, relieve the pilot wheels of some load, and intensify the pressure on the drivers and therefore apply a maximum load to the rail.

As to the fiber stresses in the rail which would result from these two locomotives, coupled together in the usual manner, it can not definitely be stated. Earlier tests of track have shown that the effect on the rail per ton of wheel load varies with different types of engine and with the different wheels of the same engine.

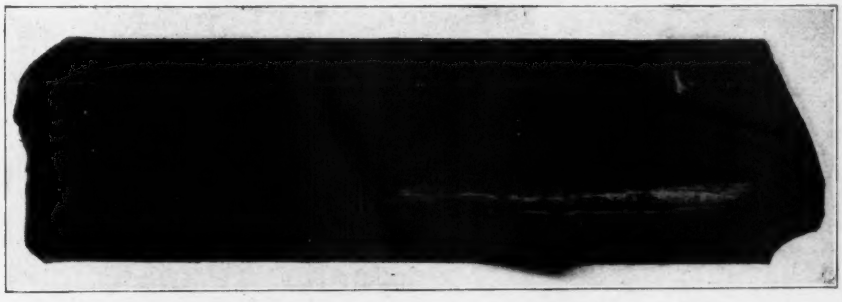
Polished and Etched Cross Sections, Showing Seams on Head on Gage Side of Rail, and Slag Split in Web.

Those earlier tests showed still further that direct measurements in the track were essential for determining the fiber stresses in the rails—the wheel loads, tie spacing, and moment of inertia of the rail section, constituting all the data available for such computation, not being adequate for the purpose. The depression of the roadbed so modifies the conditions that direct experiments in the track are required to furnish this information. The supply of information of this kind is very meager, and it is desirable that track tests be conducted to furnish data on present conditions, which may in some respects be more severe than those which pertained to track and equipment at the time the earlier tests were made.

One of the illustrations shows a faint line about half way down the depth of the head and on the half of the gauge side. This line, about one-half inch long, represents a

crack or fissure in the head, viewed on end; that is, a longitudinal crack the surface of which inclines downward toward the gauge side of the head. It therefore appears that in the head of this rail are witnessed both transverse and longitudinal cracks or fissures, each kind being found in the metal of the gauge side or half of the head.

In cutting off the head from the web of a fragment in the planer, the detached head sprung into a curved shape, with the running surface on the convex side. The deflection at the middle of the length of the piece, 5 feet long, was 0.20 inch. The deflection represented the release of internal strains of compression at the running surface of the head. This points out an important feature to consider in reference to the development of internal fissures such as were witnessed in this rail. The cold rolling of the running surface of the head of the rail by heavy wheel pressures has introduced internal strain in the steel at and for a short distance below the running surface. Those internal strains are of compression, and they reach their greatest intensity on the gauge side of the head where flow of the steel takes place in a lateral direction. That lateral flow is shown by the ridge or fin of metal which was formed along the gauge side of the head. When the rail is intact and the top surface or layer of metal of the head is in a state of initial compression it follows that there must be an opposite strain of tension to balance it in some portion of the rail. The tensile



Under Side of Head, Showing Slag Split Web.

End Views of Fractured Rail.

component would be expected in the vicinity of and next below the part which was affected by compression strains, and this leads to an explanation of the presence of fissures in the head where they are being formed. No foreign substance in the steel is needed to account for the inception of those fissures. The introduction of internal strains in a hard and less ductile steel than heretofore used for rails, under excessive wheel pressures, seems adequate to explain the occurrence and frequency of these interior fissures.

The fissures, if this explanation of their origin is true, should not be found in new rails, unused, and it is understood that the steel company that rolled this particular rail has been unsuccessful in finding any such fissures in new rails, notwithstanding a very energetic effort has been made to discover them. These fissures are not held to be defects resulting from improper mill practice. They appear to be the result of excessive wheel pressures acting on a very hard steel, steel which is hard by reason of its chemical composition.

This development of internal fissures and seams, transverse and longitudinal, suggests that the limit of wheel pressures in conjunction with the bending and shearing stresses which occur simultaneously therewith has been reached and surpassed on rails of usual width and shape of head. The frequent occurrence of broken rails is a warning of this kind.

In the earlier days of steel rails softer and more ductile metal was used. The wheel pressures were lower then than they are at present.

With increased wheel pressures harder steel was employed to give endurance to the rails. For a time it seemed that the metal of the rail was worn away by abrasive action about as fast as the immediate running surface of the head was affected by the cold rolling. The wheel pressures were not at that time so great as to disturb the steel in a serious manner at the head in the case of hard rails.

Soft steel rails would flow under the increased wheel pressures and while the metal of the running surface of the head became very brittle in consequence of the cold flow, yet the ductility of the steel was adequate to prevent the formation of interior fissures in the zone of the head below the affected metal.

Internal strains of compression were introduced the same then as now, but the toughness of the steel enabled it to endure such conditions without rupture.

There must be a limit in the combination of hard steel rails and high wheel pressures beyond which it is unsafe to go. Recent evidence indicates the approach to that limit in current railroad practice, if it has not already been passed.

It can hardly be a coincidence that all of the rails which are displaying these interior fissures have hidden structural defects on one side of the head and none on the other, and chance to be laid with the defective side on the gauge side, where it is found. Evidence points to track conditions as accountable for the development of these fissures. They have been found as close together as 8 inches from one to another.

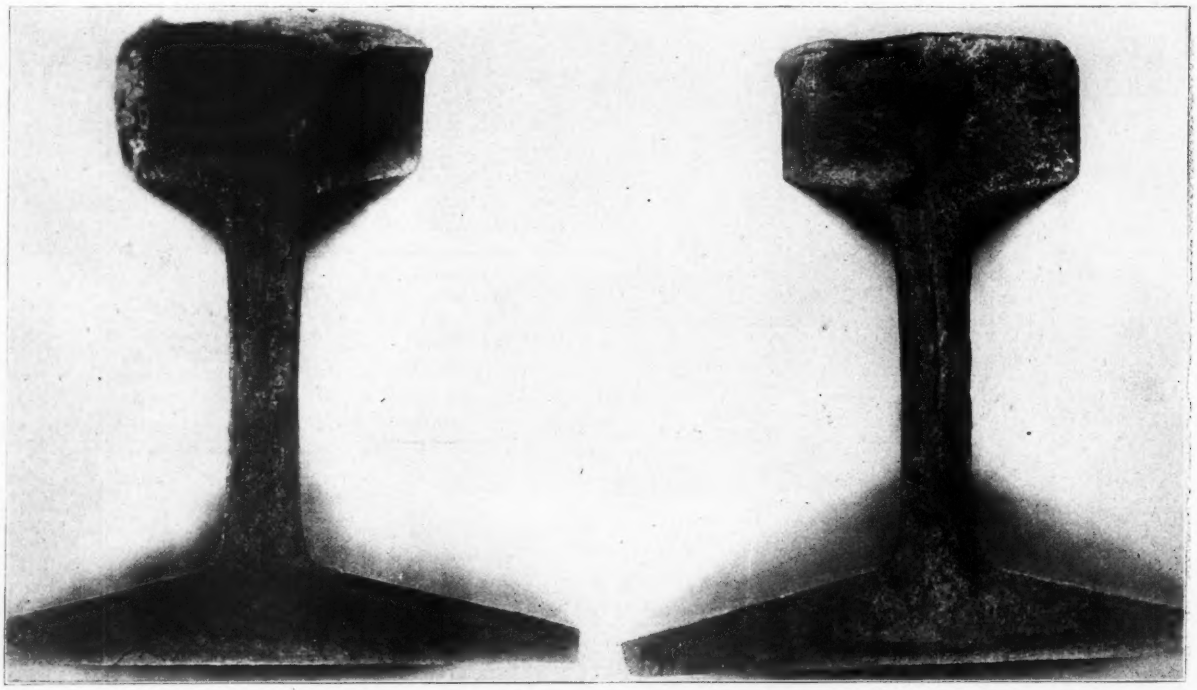
Progressive fractures have occurred in axles, but they started at the surface where the fiber stresses were greatest, and not at the interior where bending stresses would be very much less. The failure of axles by repeated stresses does not appear to furnish the same kind of an example as witnessed in the present rail fissures.

The rail fissures have their origin or incipiency in the head at places where the stresses from bending loads on the rail would be not over 75 per cent of the maximum fiber stress.

Some parts of the track are subjected to more severe conditions than other parts. Places where the stresses on the head from the wheel pressures are reversed in their direction would afford examples of maximum severity. Such places are found where the trains stop and start at stations.

When stopping a train all wheels equipped with brakes tend to force the metal in a forward direction, whereas when starting a train a longitudinal impulse is given by the driv-

ing wheels in a backward direction. Ordinarily this reversal of stresses should contribute toward earlier rupture of the steel than where the maximum stresses are seldom reversed. Of course, all wheels of a train excepting the drivers of the engine in a degree tend to force the metal in a forward direction. This particular rail was near a station, and where frequent stops and starts might be made by reason of the presence of the crossover. The actual intensity of the stresses would be due to internal strains plus external loads. A given weight of engine might successfully pass over a rail in its original state from the rolling mill and later on cause a fracture in the same rail by reason of the introduction of internal strains from the cold rolling of the wheels. The metal of the head is alternately in tension and compression according to the position of the wheels of the engine. Concerning the number of repetitions of loadings, the number for a period of 10 months would be comparatively small, so far as pertains to the number of times an engine loaded the rail, while for many of the cars the wheel pressures would be much less and strain the rail correspondingly less. It is important to ascertain what fiber stresses are developed in the rails under the wheels of locomotives of the present type. This part of the subject was experimentally inquired into some 15 years ago, since which the types of engines have greatly changed. It is quite important in view of these developments that information as to the fiber stresses be acquired for present track conditions, and such information can be acquired only on the rails when in the track, so materially does the depression of the roadbed affect the strains. In connection with the present case it may be remarked that a derailment occurred in the State of Massachusetts about five years ago, the circumstances attending which might cause it to be taken as a precursor of current experience in the use of hard steel for rails. This rail had short transverse fissures started in the head at the running surface caused by the flow of the metal from drivers slipping, heating the high carbon steel, hardened it, and causing fissures to develop. Not quite a parallel case, but one illustrating the tendencies in hard steels to reach a condition inducing fractures.



End Views of Fragments of Rail, Showing Transverse Fissure.

Conclusions.

In conclusion, it is believed that present evidence points to the inference that the primary cause of the Manchester wreck was the formation and development of transverse fissures and longitudinal seams in the head of this rail which eventually fractured in the track, aided by the defective metal of the web. That the formation and development of the internal fissures is due to the use of a hard steel and subjecting it to high-wheel pressures, wheel pressures which are excessive from a metallurgical point of view, thereby causing the development and introduction of internal strains, and those internal strains in turn together with the wheel loads caused the development of interior fissures, and their extension to a dangerous degree. That such interior and hidden fissures are a menace to the safety and lives of persons traveling over such rails.

That recent occurrences suggest the thought that current railroad practice in the use of hard steel rails and high wheel pressures has nearly or quite reached the limit of endurance of the metal of the roadway.

That it is not a question of mill practice in the manufacture of the steel, further than that the mills are making the steel which they are required to make under the specifications given them.

That present developments are not inconsistent with what is known about the properties of steels in respect to the effects of intense local overstraining pressures of which high wheel pressures furnish one illustration, combined with high tensile, compressive, and shearing stresses. In a way, it is a question of repeated stresses, but the number of repetitions of loading of this rail was comparatively small from its short time in service. It may be remarked that certain rail specifications require higher carbon steel as the weights of the sections increase, and also higher carbon steel for open-hearth rails than for Bessemer rails. In view of current developments, if the causes of formation of interior fissures are those herein described, then the employment of high-carbon metal is attended with dangers not apparently

recognized in the drawing up of current specifications. It is desirable that measurements be made in the track of the fiber stresses which are caused by the new types and weights of locomotives in order to acquire necessary information to judge of the severity of the strains which the rails are being daily exposed to, information which is now lacking. Finally it may be said, referring specifically to the development of the short transverse fissures in the heads of the rails and which are found on the gauge side of the head, that they are believed to constitute a grave danger. If, as now supposed, they are the direct result of high wheel pressures acting on hard steel, then the danger is widespread. The Manchester rail, omitting reference for the time being to the slag split in the web, was fissured in many places. Apparently a number of transverse seams and longitudinal fissures were developed in the track, as the result of a few months' service. The fissures occupied positions in harmony with the explanation of the cold rolling and shearing effect of high wheel pressures acting on a steel too hard to respond without the development of interior fractures. The effect was necessarily intensified by the bending stresses on the rail from the direct downward loads.

The limit of endurance of iron rails was reached long ago. Train loads and wheel pressures soon became too great for iron rails to stand up under and they were replaced by steel rails.

There is undoubtedly a limit to the endurance of steel rails as well as in the case of iron. It is important to ascertain whether the great lesson of the Manchester disaster does not lie in the direction of signifying that the danger zone of steel rails has been reached and possibly entered by current railroad practices.

If the above explanation is found correct, then the remedy does not consist in increasing the weight of the rail, but in diminishing the intensity of the wheel pressures and lowering the direct compressive and the bending stresses.

While the Manchester rail was defective in the web the feature which seems most grave is the general shattering of the integrity of the rail, apparently coming from the combination of a hard steel and high wheel pressures.

Complete data are demanded by this inquiry into the causes which contribute toward this destruction of the structural integrity of the steel—data on track conditions, such as the actual fiber stresses which are realized under the weights of different types of locomotives and under the different wheels of those different engines in track in ordinary condition, and from the metallurgical observations on steels of different degrees of hardness.

INDUSTRIAL ACCIDENTS.

The Pennsylvania has in the past year reduced industrial accidents in its shops from 8.7 per 1,000 employes in a month to 3.5 a thousand. "Industrial accidents" run up into the thousands on railroads, but everything from a scratched finger to a broken head is reported. That many broken legs, crushed fingers, countless contusions and other injuries resulting from accidents were unnecessary was the conviction of officers of the Pennsylvania Railroad when in November, 1910, they began a vigorous campaign of education among the employes. At the same time experts were employed to inspect the larger shops that they might show the company where safety devices could be installed to reduce the chances of accidents. Motive power inspectors of the railroad accompanied the experts on their inspections.

The benefits resulting from this inspection were so marked that making industrial inspections of shops has become a fixed policy with this railroad. Since the adoption of this plan sixty-six shops have been inspected. Reports were made to the general manager, and practically all of the recommendations offered have been adopted.

Following is a report for 1911:

Month. 1911—	Number of Shop Employes.	Killed.	Serious Injuries Per 1,000 Employes.
January	34,127	4	8.7
February	34,171	7	7.3
March	32,899	0	8.3
April	31,380	1	6.0
May	34,694	3	7.9
June	34,601	1	5.2
July	31,641	2	4.7
August	32,512	2	3.4
September	32,932	0	3.4
October	33,462	0	3.2
November	33,997	2	3.5

These results were accomplished on a most economical basis. The reports resulting from inspections contained in all 3,126 recommendations covering improvements or changes in 3,737 tools or machines, at an estimated cost of 35,000, or an average of $530 for each shop. In many cases it was not that expensive. At one shop for which 238 recommendations were made 157 covered improvements made with practically no cost. Shopmen themselves have most at stake in the accidents and the organization of shop safety committees of the rank and file has proved invaluable. As the railroad states: "The prevention of industrial accidents depends largely on the care exercised by the individual workman. By serving on the safety committees they become interested in precautions and will instinctively avoid many of the common and preventable dangers." Inquiry develops that even laborers serve on these committees of protection.

A terminal division committee is composed of a locomotive inspector, a brakeman, baggage porter, track foreman, yard foreman, usher and relief assistant trainmaster.

A road and yard committee is composed of a passenger engineman, freight conductor inspector of car repairs, telegraph operator and a laborer.

These are standing committees, the members of which are changed from time to time. The recommendations they make are simple and cover a wide range of subjects, such as criticisms of a somewhat general character referring to recommendations for coaming strips for shop elevators, stairways and floor openings, protection for exposed gears, band saws, exposed set screws, safeguarding of all belts and pulleys, conduit for wires from rheostat boxes, protection for counterweight chains, boxing of weights and installation of guard rails at points where workmen may be exposed to belting or moving machinery.

The Pennsylvania announces that its efforts to reduce industrial accidents will be redoubled in the present year. In accepting the medal by the American Museum of Safety, a vice-president of that company said that the great value of the medal his company received for what it did in 1911 to protect its employes lay in the incentive to its officers and employes to still further achievement.

PREVENTION OF DAMAGING FIRES.

A western railway, to notify section men of fires along the right of way, makes up a number of small sheet iron plates, on which the word "fire" is printed. Each locomotive in the service is equipped with one or two of these plates. In case of a fire along the right of way, the engineman throws off the plate to the next section gang he passes, and the latter then immediately places hand cars on the track and runs back until the fire is found.

The Signal Department

EXTRACTS FROM THE FOURTH ANNUAL REPORT OF THE BLOCK SIGNAL AND TRAIN CONTROL BOARD.

In its last annual report to the commission the Block Signal and Train Control Board noted that at that time 985 plans of appliances and systems intended to promote safety in railway operation had been presented to it for examination, and that 819 of these had been disposed of. Since the date of that report plans of 96 additional devices have been presented, making a total of 1,081 cases which have been brought before the board to date. During the past year 93 cases have been disposed of, and the board now has 169 cases before it for consideration.

Devices Approved for Test.

In its report last year the board presented a list of 18 automatic train-control devices which upon examination were considered to possess sufficient merit to warrant the board in offering to test satisfactory installations. During the past year three additional automatic train stops have been approved for test, as follows:

(1) Jones Signal System Co., of Atlanta, Ga. Mechanical trip automatic train stop of the ground-contact type.

This is an improvement on the device installed experimentally on the Roswell branch of the Southern Ry. near Atlanta. Permission to install this device has been secured from the New York Central, and arrangements are now being made to install it on the Niagara Falls division of that road between Buffalo and Niagara Falls.

(2) The Jones Safety Train Control System Co., of Baltimore, Md. Electrically operated automatic train stop of the intermittent contact rail type.

This device was approved for test on February 1, 1911. An installation has been made on the Western Maryland near Baltimore. Owing to the clearance conditions existing on this road, some difficulty has been experienced by the proprietors of the device in making their installation in a form that would be suitable for a satisfactory test. It is expected, however, that this difficulty will be overcome and that the contemplated test will be made during the present winter.

(3) International Signal Co., of New York, N. Y. Automatic train stop of the mechanical trip type controlled electrically.

In this system a ramp is fixed on the track in the path of a hanger or plunger carried on the locomotive, the upward movement of which opens a valve in the train line, applying the brakes, unless an arm carried on the locomotive is struck almost simultaneously by a movable roadside contact member working in connection with fixed signals. Movement of this engine arm closes a valve and prevents the application of the brakes.

Gray-Thurber Train Control & Signal Co., of Pittsburgh, Pa. As noted in the board's last annual report, this is a cab signal and automatic train stop requiring short sections of insulated track rails and the insulation of either a truck from the remainder of the locomotive or the locomotive from the tender. It was approved for test on October 21, 1909, and it was expected that a contemplated installation on the Lake Shore & Michigan Southern near Cleveland, O., would be completed and offered to the board for test during the winter of 1910-11. Owing to delay caused by track changes on the Lake Shore this installation was not made, and as an installation of the same device was being made on the Pennsylvania line near Pittsburgh it was decided to abandon the contemplated installation on the Lake Shore and use the Pennsylvania installation instead. This installation has been completed, and the proprietors are now making preliminary tests for the purpose of satisfying themselves respecting the proper operation of the various details of their apparatus before turning the installation over to the board for official test.

Devices Tested.

Tests of three automatic train-control devices have been completed during the year, as follows:

(1) The cab signal and automatic train stop of the Electrical Automatic Railroad Safety Signal Co., of New York City, noted in the board's third annual report as having been approved for test May 28, 1910. This was installed on 3½ miles of Staten Island Rapid Transit Ry. Three locomotives were equipped, and tests were conducted from February 27 to April 4, 1911, inclusive. These tests disclosed constructive faults in certain details of the apparatus, but it was the conclusion of the board that if these faults were remedied, the system, with proper inspection and maintenance, would be reasonably reljable and would tend materially to promote safety upon a railroad using it. A report setting forth the results of the tests in detail and stating the findings of the board was forwarded to the proprietors of the device on August 28, 1911. Subsequent to the date of this report the proprietors redesigned those units of the apparatus which had failed to work satisfactorily, and further tests were conducted by the board from November 8 to 16, 1911. These tests demonstrated to the satisfaction of the board that the constructive faults previously pointed out had been substantially remedied.

(2) The device of H. G. Warthen, of Washington, D. C., approved for test November 2, 1908, and which was noted in the last annual report of the board as at that time being installed, was offered for test on April 12, 1911. The installation covered about 4½ miles of road on the main line of the Buffalo, Rochester & Pittsburgh near Rochester, N. Y. One locomotive was equipped. The test continued from April 12 to 26, 1911, inclusive. This device is an electrical automatic train stop of the intermittent contact type. As installed, the contact points were located in the center of the track about 22 feet above the level of the running rails, necessitating the use of an overhead trolley. The results obtained from tests of this device were unsatisfactory. It was found that the electrical circuits were not properly designed and the method of making contact by means of an overhead trolley was objectionable. The conclusion of the board, therefore, as a result of these tests, was that the Warthen device, as then installed, could not be recommended for use. It is understood that the proprietor is redesigning his apparatus with a view of overcoming the faults disclosed by this test, but the board has not yet had an opportunity to study this revised apparatus.

(3) The mechanical trip automatic train stop of the Railway Automatic Safety Appliance Co., of Wilmington, Del., noted in the board's last report as having been approved for test on December 21, 1910, was installed on the tracks of the Pere Marquette near Saginaw, Mich., and was tested by the board from March 24 to May 16, 1911, inclusive. In this device the trips employed are located at about the level of the buffer beam on the locomotive pilot. In the Saginaw test two track trips were installed and four engines were equipped. The test disclosed constructive faults in certain details of the apparatus used, and after a careful analysis of the results obtained the attention of the proprietors was called to these constructive faults. The proprietors have redesigned those details of the device that failed to work satisfactorily, with a view of overcoming

the faults disclosed by the test, and it is expected that the redesigned apparatus will be subjected to further test during the present winter.

From figures collected by the board under authority of the commission it appears that on January 1, 1911, there were 71,269 miles of railroad in the United States operated under the block system. Of this mileage 17,771.5 was automatic and 53,557.6 was manual. The increase in mileage of road block signaled over the previous year was 5,511 miles, more than three-fifths of which, or 3,473.8 miles, was automatic.

As compared with the total road mileage, over 240,000, the number of miles worked under the block system is small. Moreover, the increase in mileage indicated by the figures now under consideration was practically all upon roads that already had the block system in use. The extension of the system to new roads—that is, to roads which had not before used the space-interval method of train operation—was not such as to warrant the belief that the block system will be brought into use generally within any reasonable period of time without governmental action compelling it.

There is ample justification for such action when the number, and particularly the disastrous character, of the collisions which have occurred under the time-interval or train-dispatching system is considered, together with the small cost of installation and operation of a simple form of the block system which would very materially diminish the chances of collisions due to defects inherent in the dispatching system.

Automatic Train Stops.

In its last report the board noted an increased interest on the part of the railroads themselves in the development of automatic train-control appliances. As was shown by the annual statistics published by the commission as of January 1, 1911, automatic train stops are in use on the lines of the Washington Water Power Co., the Pennsylvania R. R. in New York City, the Hudson & Manhattan R. R., and the Erie R. R., and there is now an installation on the San Francisco, Oakland & San Jose Ry.

The information obtained from the three tests described in this report, together with knowledge of the general state of development of the art of automatic train control leads the board to conclude that there are several types of apparatus and methods of application which, if put into use by the railroads, would quickly develop to a degree of efficiency adequate to meet all reasonable demands. Such devices properly installed and maintained would add materially to safety in the operation of trains. In many situations, under conditions existing in this country, the board is convinced that the use of automatic train stops is necessary to the safe operation of trains.

(To be continued.)

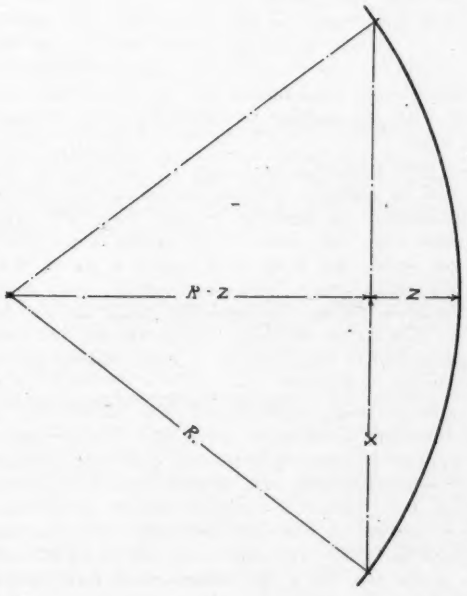
The Maintenance of Way Department

DEGREE OF CURVATURE.

Editor Railway Engineering:

Kindly inform me as to the proper length of string to use, to find the degree of curves. I refer to a string of such length that if the ends are held on the gage side along a curve, and the string drawn tight, the number of inches between the gage side of the rail and the string will be the degree of the curve.

Yours truly,
Chas. McBride.



If a curve is properly lined, the degree of curvature may be obtained by measuring the mid ordinate of a chord of 61.8 ft. The number of inches from the rail gage to the string at its center, is the degree of curvature.

In the figure $x = \frac{1}{2}$ the long chord desired, in feet.
$r =$ the radius of curvature, in feet.
$z =$ mid ordinate, in feet.

From the right triangle

$$x^2 = r^2 - (r - z)^2$$
$$= r^2 - r^2 + 2rz - z^2$$
$$x^2 = 2rz - z^2$$
$$x = \sqrt{2rz - z^2}$$

Letter $z = 1$ inch ($= 1/12$ ft.) for a 1 degree curve, and substituting for y the radius ($= 5{,}730$ ft.) we obtain

$$x = \sqrt{2 \times 5{,}730 \times 1/12} - 1/144 = \sqrt{955} = 30.9$$

(dropping the fraction 1/144).

The chord desired is $2 \times 30.9 = 61.8$

The fraction z^2 has very little effect on the result. For instance with a 48 degree curve, in which $r = 119.42$, and $z = 48$ inches $= 4$ ft., we have

$$x = \sqrt{2 \times 119.42 \times 4 - 16} = \sqrt{955.36 - 16} = \sqrt{939.36} = 30.6$$

The whole chord would be $2 \times 30.6 = 61.2$. Even with a 48° curve, therefore, this method approximates the result closer than practical measurements could be made of the mid ordinate.

The chord which will give a mid ordinate in tenths, which corresponds to the degree of curvature, is 67.6, using the above method.—[Editor.]

RAIL RAVELINGS.

Pointers on Track, from an Ex-Roadmaster.

Dear Dad:

Your recent letter is at hand, and the advice is so much to the point that I think I will ask you to accept the position of "Consulting Roadmaster," a title which, however, will carry no salary, for as you know the section foremen under present conditions are the poorest paid men on the railways, considering their responsibilty.

You know something of the conditions on my section, the track is new, having been recently finished by the construction forces and turned over to the maintenance department. The section is a long one, including seven miles of main line and a medium sized yard, containing 32 switches (added recently). There is a fair amount of tangent on the main, and only one curve that is very sharp. This is a 4 degree curve which starts about the middle of a cut. And just now this cut is causing me a lot of trouble. The grade is very soft clay and has been heaving badly. This cut should have had more attention, I think, before the frost set in, for in many places the clay has oozed up and displaced the ballast between and under the ties. About the only thing I can do now is shim it up, and I find that some part of this cut needs attention every day. Luckily, we have a quantity of shims. (I say luckily, for you know the engineers usually forget to order shims; and some of them, hate to admit to a track foreman that they ever make an omission or a mistake, and so refuse to fulfill his requisition.) So far the track has not heaved so unevenly that I have been forced to shim very high, but am afraid that pretty soon I shall have to go above the 1½ in. shim. My experiences with shims have been rather limited, and mostly on newly constructed tracks, where the grade settled, but did not heave. If you can give me some pointers on shimming in your next letter, they will probably help me out of my difficulties.

When I arrived on the section just a few days before frost set in, the track was in pretty poor condition. In many places it was out of level, especially at the joints. It was another one of those cases where a conscientious track man wants to start in and raise the whole track out of face, a condition we frequently used to meet with in the construction department when the track was turned over for operation on short notice. In a case of that kind we wanted to turn over the tracks in the best possible condition. You remember what a hard time you had teaching me to go along on a track like that, and pick out only the very worst low places, the places where one joint was out of level badly, or where a joint was low on one side and the next joint was low on the opposite side, causing the cars to rock.

I knew that we would have frost soon and must run over that whole section in a week or so. I was lucky enough to find that one man in the section gang (a rather large gang) had been an assistant foreman, and could raise tracks and handle the men. I gave him instructions to raise only such portions of the track as I marked, and then each morning I went ahead of the gang and marked the places which required attention in about a mile of track, trying to gage the amount of work I marked up, so that the gang could cover the work that day. After this I would return to the gang and do the raising, so that every laborer would be used to hurry along the work. I took out the worst kinks in the line at the end of each day's work. In a little over a week we covered the entire section, and had the satisfaction of being told that the track rode much more smoothly than before. However, this new track will not be in shape for anything but pretty slow traffic this winter.

Dear Son:

And so they have given you charge of a yard in addition to your section. I hope that in your case they did not do the usual stunt of railway officials, that is, increase your duties and responsibility without a corresponding increase in salary, as they did in several instances with me during my railway experience.

Your position now is almost an exact parallel of my first charge. A yard containing 32 switches and also a section, the difference being that you have new track while I had an old line and a rotten yard to start with. Your method of handling the track in preparing for cold weather on short notice was good. There are plenty of track foremen who can do first-class work, but it is difficult to find one who will go ahead on track such as you had and make it a fairly good riding track with a small amount of work. They seem to be afraid of criticism from other trackmen.

The 4 degree curve in the cut with the soft roadbed which you speak about shimming is a proposition that would probably puzzle many older heads than yours. I believe you use the ribbed bottom tie plate. As a rule when shimming on new ties with these plates it is most convenient to remove the tie plates. Shim under your base or joint plates. The tie plates can many times be used to advantage for rail braces. Be sure you brace your track effectively when shimming on a curve. Angle bars can be used for braces if the latter are not available. For high shimming you can use 2-inch plank for braces, cut in lengths such that, when one end is placed against the web of the rail the other end will come far enough from the end of the tie to permit track spike to be driven against, not through it. Braces should be placed on every alternate tie on your 4 degree curve. If the heaving becomes excessive and you have to shim over 2 inches, cut 2-inch plank into 2-foot lengths, spike them firmly to the tie with boat spike and shim on top of these, bracing as above. These plank should be bored for the track spike to prevent splitting. Track may be shimmed safely in this manner to almost any desired height by increasing the thickness of the plank but when using a thickness of 3 inches or over it is best to cut the plank long enough to reach under both rails, where track has heaved alike on both sides so as to permit this. In cases of heavy shimming extra long "frost," or "shim" track spik should be used if it is possble to get them. Be very careful when shimming not to get the track "kinky," and out of line.

When the clay has heaved up through the ballast you will have trouble when frost goes out. If possible, get your roadmaster to give you some cinders to unload at this place and as soon as frost is out to the bottom of the ties, dig out the clay and old ballast and replace with the fresh cinders. This will tide you over until settled weather comes. If this piece of track had been treated in this way in the fall, before frost came, your troubles would have been much less at this time, but I suppose it was the old scrap between the Construction and Maintenance Departments that left it without proper attention, each one wanting the other to go to the expense of fixing it up.

Your yard work even in a yard of that size will require a good deal of attention. Prepare for storms by removing ballast to one-half the depth of the ties under all switch and connection rods, also under switch points, stock rails, guard rails and spring rail frogs thus making a pocket for snow. This will enable you to keep your switches clear more easily when snow is falling. In removing ballast do not dig more than six inches from the flange of the rail on either side (except under switch rods) so as to avoid making pit falls for trainmen and switchmen.

In case of heavy snowfall you will indoubtedly be compelled to employ a number of green men. Put a couple of new men with one of your old heads and give them a certain number of switches to take care of covering all the switches and crossings in the yard in this way and instructing the experienced hands to see that the new men keep busy. If you arrange your men properly in this way your work will be greatly simplified, and it leaves you free to go to any and all parts of your yard to look after the work. I used to gather a force of men in

cases of heavy storm and assign them in this manner to cover over 200 switches and several street crossings before we left the tool house. You will probably have to have a train to remove snow from the yard at times, but you will find that there will be places where snow will have to be carried for some distance to get it out of the way. Prepare for this by making boxes to hold, say, twice as much as a dirt barrow. Nail a strip on each of two sides, letting them project three feet each way for handles. Use these for carrying out the snow. This is a simple device that will be of considerable value to you.

Watch the flangeways in crossings and as far as possible prevent snow and ice becoming packed solidly in them, as this condition will cause your crossing plank to heave up and cause trouble. This of course will not occur if you have rail turned on the side and balled in under the head of the track rail through crossings. Your guard rails will need to be watched to keep the flangeway from filling with ice and snow and causing either the main line rail to "spread" or the guard rail to tip over, or both. This is a condition very apt to exist where switching is going on constantly, the drip from the engines causing it to a great extent.

I hope your company is not practicing the expensive economy of most roads, cutting down wages and hours and by so doing forcing old and experienced track laborers to look for more lucrative employment, compelling you to employ a poor class of foreign labor which is not cheap at any price.

New Literature

The American Museum of Safety, New York, has recently gotten out a safety bulletin entitled "Yard Practice, Walks and Railings." This booklet contains a number of illustrations of places wherein practical safety devices have been adopted. Each photograph is accompanied by a description, explaining the need for and the details of the safety device.

* * *

The Akme System of reinforced concrete construction is accurately described in a catalogue issued by the Condron Company, structural engineers, 33 W. Jackson Blvd., Chicago. This system is a reinforced concrete column and slab construction for buildings of all kinds. The booklet is gotten up in very attractive style with excellent illustrations and descriptions.

* * *

The Hupp Automatic Mail Exchange Mechanism is described and illustrated in a folder issued by the inventor, Albert Hupp, Kansas Cty, Mo. The operation of the system is described, and the illustrations are from a number of installations already in use.

* * *

The Ferro Machine Foundry Company has issued a very attractive catalogue on Ferro Engines. The booklet is a practical treatise on the correct design and construction of marine engines and equipment. The catalogue is heavily illustrated and the descriptions are complete and satisfactory.

* * *

The National Tube Company has issued a bulletin describing National coating, which is a system of protection for iron and steel against external corrosion, either by water or electrolysis. The method of applying the coating is given with several illustrations.

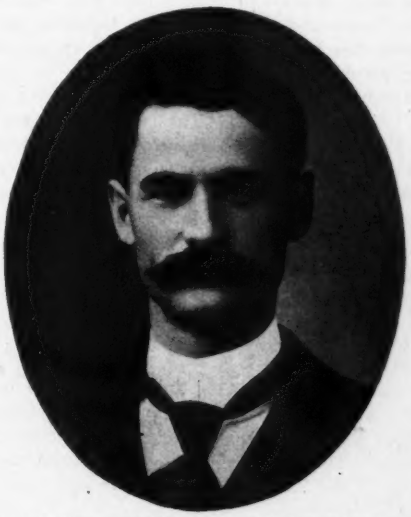
Personals

E. E. Mashburn has been appointed engineer of maintenance of way of the Missouri & North Arkansas, succeeding F. J. Allen, office at Eureka Springs, Ark. Charles Gilbert has been appointed purchasing agent with office at Eureka Springs, succeeding E. C. Overstreet. D. P. Cunningham has been appointed roadmaster at Eureka Springs, Ark., succeeding J. B. Skelton. J. H. Haworth has been appointed roadmaster with office at Leslie, Ark., succeeding D. P. Cunningham.

Guy Scott, division engineer of the Central system of the Pennsylvania Lines West, office at Toledo, O., has been appointed division engineer of the Northwest system, office at Fort Wayne Ind. Mr. Scott succeeds Fred M. Graham, who has been transferred to Chicago as division engineer maintenance of way, succeeding J. W. Barrie, resigned.

The jurisdiction of H. W. Davis, purchasing agent of the Norfolk & Southern, has been extended over the Raleigh, Charlotte & Southern.

Henry Steele has been appointed roadmaster of the Bellingham Bay & British Columbia, headquarters at Bellingham, Wash., succeeding Charles Gilroy, assigned other duties.



F. L. Nicholson, Chief Engineer Norfolk Southern Ry.

Sanford F. McLeod has resigned as purchasing agent of the Duluth, Missabe & Northern, and will engage in private business. Fred H. White, purchasing agent of the Duluth & Iron Range has been appointed to succeed Mr. McLeod, with office at Duluth, Minn.

E. F. McCrea has been appointed division engineer of the Pennsylvania Lines West, Central system, with office at Toledo, O., succeeding Guy Scott, transferred.

Ernest A. Sterling has resigned as forester of the Pennsylvania to open an office as consulting forest and timber engineer, 1331-32 Real Estate Trust Bldg., Philadelphia, Pa.

P. H. McFadden, formerly roadmaster of the Great Northern at Everett, Wash., has been appointed assistant engineer maintenance of way of the entire Western district and also the Butte and Montana divisions of the Central district. The office it at Seattle, Wash. John Sesser, assistant engineer maintenance of way, now has authority only over the Lake and Eastern districts, and the Minot division of the Central district.

O. A. McCombs has been appointed roadmaster of the Texas & Pacific, with office at Dallas, Tex.

D. W. Lum, consulting engineer and F. L. Nicholson, chief engineer of the Norfolk Southern, have both had their jurisdiction extended over the Raleigh, Charlotte & Southern. The office is at Berkeley, Cal.

Ralph P. Moore has been appointed purchasing agent of the Duluth & Iron Range, with office at Duluth, Minn. Mr. Fred H. White, formerly purchasing agent, has resigned to accept service with another company.

Andrew Fiola, section and extra foreman on the Great Northern, has been appointed roadmaster, with office at Garretson, S. Dak.

H. A. Woods, assistant chief engineer of the Grand Trunk Pacific at Montreal, Que., has been transferred to Winnipeg, Man., and will have charge of the construction of branch lines of the eastern and western sections. B. B. Kelleher, chief engineer, is henceforth to devote his entire time to main line construction work through the Rocky Mountains.

E. G. Hewson has been appointed resident engineer of the Grand Trunk, with headquarters at Toronto, Ont., succeeding C. W. Power, resigned.

W. R. Cohn has been appointed roadmaster of the Rock Island Lines to succeed S. J. Rufer, resigned, with jurisdiction from Haskell, Ark., to Mile Post 97 on subdivisions 53 and 53-A.

With The Manufacturers

WATER SOFTENING PLANT, FLORIDA E. COAST, RY.

The Florida East Coast Ry., after a thorough investigation, decided to install a water softening plant at East Mayport, Fla. This water station is on the line to Jacksonville, Fla., which carries a dense freight traffic. The water for the station at this point is taken from an artesian well, and contains a large amount of scale-forming solids. The repairs to boiler tubes, stay bolts and fire boxes, were found to be excessive when using this water, so it was decided to install a water softening plant at East Mayport.

The installation consisted of a softener with an hourly capacity of 8,000 gallons. The water softener consists of a steel settling tank 14½ ft. in diameter, and 30 ft. high. In the top of the settling tank is a small rectangular tank containing an automatic measuring and mixing mechanism for adding the softening solution. The water softening apparatus automatically dumps a suspended bucket of the solution into the water, when the water gets to a certain height in a compartment of the tank. The water from the well is, at the same time, automatically diverted into a second tank above which is another suspended bucket of softening solution.

The main solution tank on the ground level is designed to contain sufficient softening solution for 12 hours' continuous operation, making attendance unnecessary oftener than once in that time. Opening the water valve at the motor places the entire plant in immediate and automatic operation.

This plant was given a thorough test both in efficacy and in economy of operation and a careful account was kept on the results accomplished by using purified water. As to efficacy, it was found that repeated analyses showed a practically unchanging quality of softened water. Analyses show that the removal of scale-forming impurities is equal to the elimination of practically one and two-tenths tons of scale from the locomotive boilers each week, with the softener operating the full 24 hours.

These results convinced the Florida East Coast Ry. that further installations of softeners should be made as rapidly as possible at points where economy demanded it, and orders were accordingly placed for additional plants. A standard capacity of 10,000 gals. per hour was adopted for all points except St. Augustine, which, being a terminal point, required a plant having a capacity of 15,000 gals. per hour.

The cost of treating water on this division in 1909, together, with interest on the investment, was a little less than $5,000. The yearly performance sheet for that year shows that 20.5 miles were run on each ton of coal burned. At the time of placing softeners in operation the locomotive performance sheet showed an average of 20.2 miles to the ton of coal. This represents a saving of $5,164.50, resulting from the use of purified water.

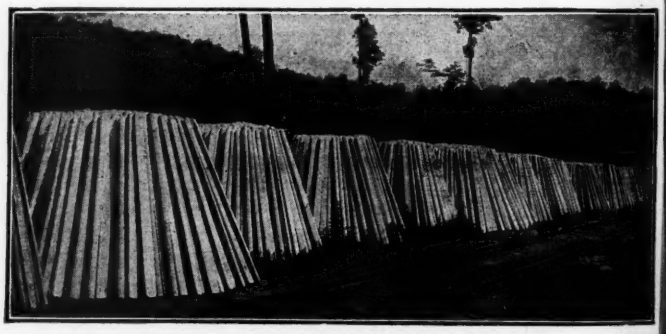
The amount of money saved in fuel alone more than payed the charges on the water softening system. In addition there was a great saving in repairs to locomotives, and in the time the locomotives previously spent in the shops. The following advantages were also derived: (1) Better train movement and less boiler failures on the road. (2) A suitable and assured water supply. (3) Heavier trains hauled for same or less expenditure in fuel.

This water-softening system as adopted by the Florida East Coast Ry. was designed by the American Water Softener Co., of Philadelphia, which did the entire work of installation, including all foundation and pipe work and housing.

CONCRETE FENCE-POSTS, D., L. & W. R. R.

Up in the mountains near Boonton, N. J., the Delaware, Lackawanna & Western has located a plant for the manufacture of reinforced concrete fence-posts for its lines. Between 15,000 and 20,000 concrete posts were manufactured at this plant in 1911. Over 300 line post moulds and 20 anchor post moulds are used at this plant, which is located at one of the several rock quarries of this company.

The posts are made from small sizes of crushed rock, ½-inch and smaller being used. The mix is made in the proportion of 1 part cement to 2 parts fine rock, and 4 parts coarse rock.



Concrete Posts Piled to Season.

Individual U-shaped sheet steel moulds are used, grouped upon a supporting frame, which holds them up from the ground about 2 feet, the supports being springs. After the reinforcement is placed and the moulds are filled, the concrete is settled by vibrating the moulds longitudinally upon the supporting springs. The filled moulds are then transferred to level ground. After taking the initial set in from 6 to 24 hours, the posts are rolled half over. The posts, which have round backs and flat faces, are left with their flat faces down on the ground to season for several days, during which time they are kept wet. After this they are piled on end to economize space, as shown in the illustration. Posts, after being made, should season for at least 60 days before they are set.

The quantity of posts already made at this plant should be convincing evidence of the satisfaction which they are giving.

The D. & A. Post Mold Co., Box 197, Three Rivers, Mich., is the manufacturer of the equipment used by the D., L. & W. R. R., and furnishes this equipment for many other large railways.

KALAMAZOO RAILWAY SUPPLIES.

The Kalamazoo Railway Supply Co. manufactures a number of devices, most of which are well known to railway engineering officials. A specially designed pressed steel wheel is used on all hand cars, push cars, motor cars, etc. By the use of special machinery constructed for this purpose, the metal in this wheel is rolled so as to double the thickness in the throat of the flange, where the greatest wear comes. The rolling process also increases the wearing qualities. The standard hand car is equipped with machine cut driving gear and pinion, accurately cut by improved automatic gear cutting machines. The axles of the car are of steel and of ample size to carry the required loads. The wheels and pinion have a taper fit, and the wheels may be easily removed if desired.

The tapering fit of wheel and axle guarantees that the wheel will aways revolve in a perfect circle, if correctly tightened. The wheel is forced into the proper position on the axle, and held there, by two nuts which screw onto threads on the end of the axle. Either high or low gearing can be had, as desired.

The Moore track drill is designed for heavy and severe work, and is built along entirely original lines. The drill is made with a detachable upright or standard. The upright is quickly erected and rigidly secured to the frame by the shifting of one lever, and is rapidly released by the same lever. The upright and rail hook can be removed to allow trains to pass, and can then be quickly replaced ready to continue drilling, without disturbing the drill bit. The drill never can become wedged and prevent the drill from being quickly broken down to let a train pass.

This drill can be used on bridges, in tunnels, in fact, anywhere on the railway. It can be fitted with either an overclutch or an under-clutch, or both if desired.

The Jenne friction jack is designed in three sizes. The smaller size, No. 0, is a one man jack designed for light track repairs. The weight is only 40 lbs., and the maximum lift is 10 inches. The No. 1 jack is designed for ordinary surfacing. It has a maximum lift of 12 inches, and weighs 60 lbs. The No. 3 jack is designed for heavy ballasting, surfacing, and general repairs. It weighs 90 lbs., and has a 15-inch lift.

A special motor car, No. 24, is manufactured by this company for railroad section work. The frame of the car is of steel, with a wooden body bolted to the frame in such a manner that it may be easily removed for renewal or repairs. All working parts are readily accessible from the deck of the car, so that it is not necessary to get under the car to make adjustments or repairs.

The engine used on this car is of the air-cooled, four-cycle type, the cylinders being built with cooling flanges running lengthwise, thereby increasing the cooling surface of the cylinders about three times. The cooling feature is further increased by the use of an auxiliary exhaust port, which frees the cylinder of at least 60 per cent of the heat left in the gases at the end of the firing stroke. This also relieves the main exhaust valves of the high temperature of these exhaust gases. The engine is complete in itself. The cylinders are bolted rigidly to the engine frame which carries the crank shaft and the cam shaft.

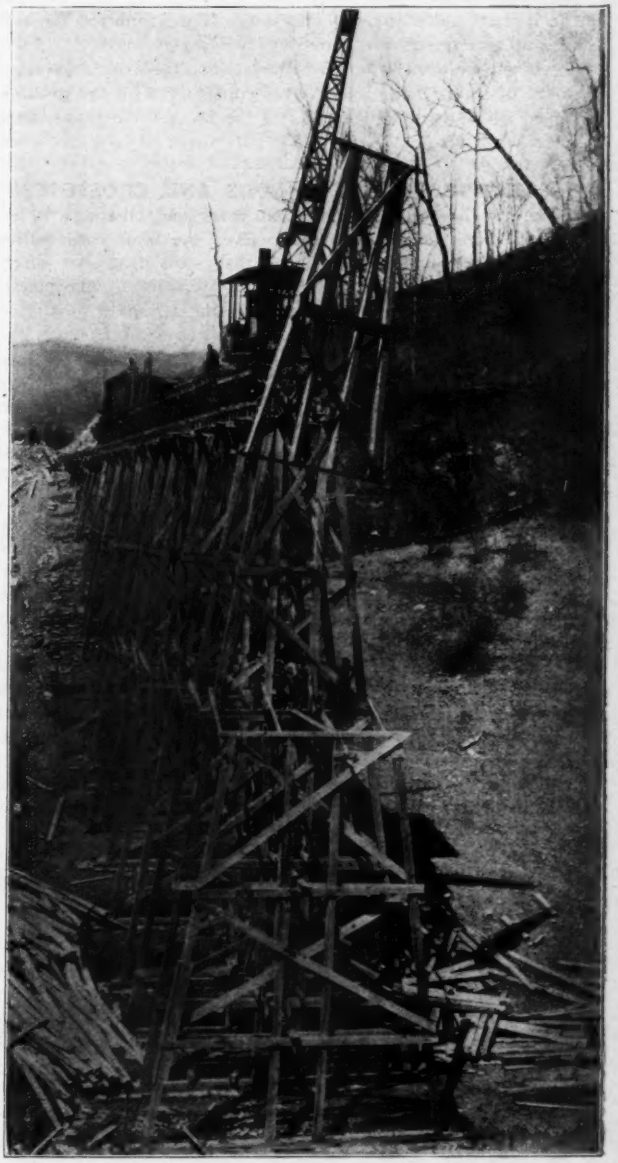
The transmission is direct to the axle by means of cut steel gears; no chain or sprocket wheels are used in the driving mechanism. The driving gears can be interchanged, making it possible to control the speed. The driving mechanism is so designed and constructed that the car may be run at the same speed in either direction. The valve motion is very simple and complete; the few working parts and the mechanical features of construction make its adjustment perfect. A cam on the crank shaft communicates with a rocker arm, trunnioned near its center, which operates the valve direct at the other end. The valves are set in vertical position at the head of the cylinders. The admission valves are above the exhaust valves and are readily accessible; in fact, by removing the flanged head both valves may be removed, reseated, or ground in with very little trouble.

The vibration, which often results with the use of a gas engine, is absorbed by counter-balancing the crank shaft and the driving, reducing motion of the gearing. All bearings are babbitted with a high-grade babbitt metal especially adapted to gas engine work. The brake is of the external contracting type and is simple and efficient. The control levers and battery box are so placed that they can be locked when the car is not in use and are arranged with the idea of convenience and accessibility to the operator when the car is in use. The lubrication of all the bearings is effected by means of grease cups, and sight feed lubricators are provided for cylinder lubrication.

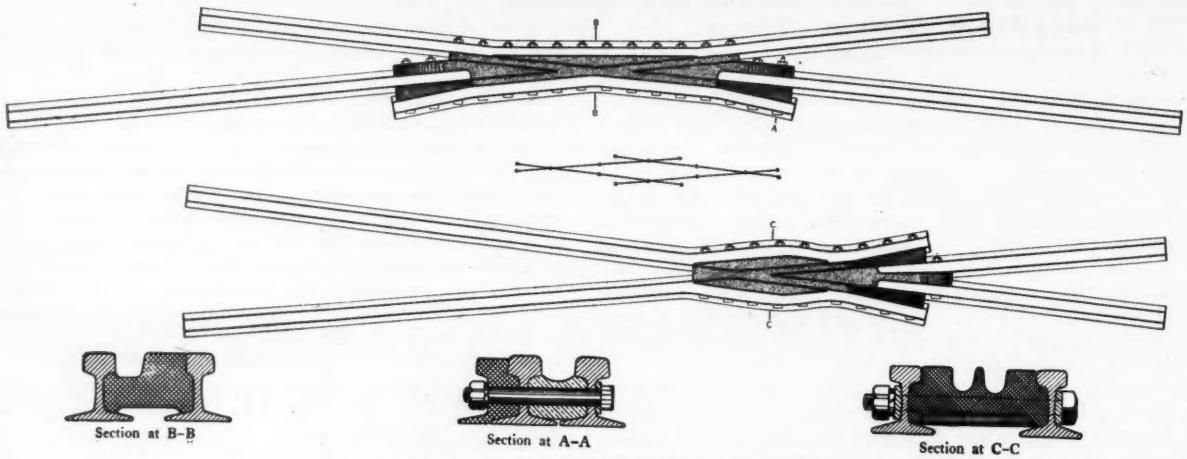
The above is a description of several of the many track tools and devices manufactured by the Kalamazoo Railway Supply Co., Kalamazoo, Mich.

BUILDING TEMPORARY TRESTLE, WASIOTO & BLACK MOUNTAIN.

The accompanying illustration shows the construction of a temporary trestle on the Wasioto & Black Mountain Rail-



Erecting Temporary Trestle.



Special Construction of Crossing for Small Angles.

road near Wasioto, Ky., using a locomotive crane built by the Browning Engineering Company of Cleveland, Ohio. T. J. Asher & Sons, contractors, have built 22 miles of railroad with this crane. The temporary trestle is 76 feet high in the highest place and 660 feet long. Time required for setting up this trestle was nine days and seven hours.

As can be seen from the illustration, the trestle is composed of frame bents which were constructed on the ground, raised into position by means of the locomotive crane, then fastened in place.

MANGANESE INSERT FROGS AND CROSSINGS.

The use of manganese steel in frogs and crossings is becoming more general each year. Even the most conservative railways are becoming convinced that solid frogs, or insert frogs, in which the inserts are of a good quality of manganese, are very economical in spite of their initial higher cost.

The cost of maintaining a manganese frog is very much less than that of an ordinary frog. There is a big saving in frog and crossing timbers, because these are soon spike killed where the ordinary bessemer steel frog is used under heavy traffic, and must be frequently renewed.

It is plainly evident that longer wearing frogs give a labor economy in frog replacements. Frog wear is greatest where traffic is heaviest and where trains are frequent. At such places the cost of renewals is highest, owing to the limited time available between trains, to the inaccessibility and difficulty of transporting track material, and to lack of space for carrying on replacement work advantageously. If traffic is delayed by replacements, that is an added expense and inconvenience which should be considered.

The economy in using manganese or manganese insert frogs in high speed interlocking railway crossings is especially evident. Such crossings are frequently on sections where very small section gangs are employed, and the frogs used are generally much heavier than a switch frog. In order to handle such replacements advantageously, laborers are brought in from other sections, entailing trouble and expense. As regards the number of men required for replacing such a frog, there is no economy as a manganese frog is at least as heavy as an ordinary frog. As regards the number of times such extra men will be required, there is a distinct saving, as the manganese frog effects a saving of the number of replacements. An economy in maintenance is effected, for the road bed is dug up less frequently, and consequently less surfacing is necessary.

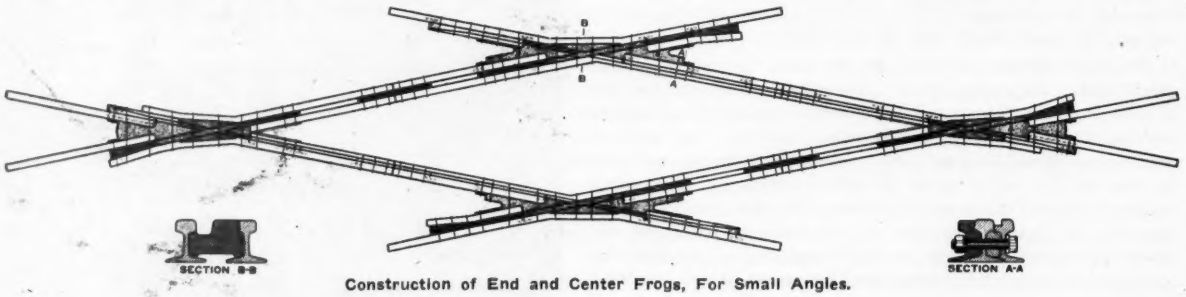
The illustrations herewith are of frogs with manganese inserts for switches and crossings. These are products of the Frog Switch & Mfg. Co., Carlisle, Pa., which have given excellent service. This company has been manufacturing railway track work for 30 years. A new plant was built in 1909, following a fire which occurred in that year. The structure is one of the largest of its kind, and is constructed of reinforced concrete. The modern equipment of this plant together with many years of experience and a rigid system of shop inspection insures excellent quality of materials, and prompt shipment of orders.

DISINFECTANT FOR PASSENGER STATIONS AND CARS.

"Nicine" is a fine powder which is an excellent absorbent, deodorant, disinfectant and germicide. It will destroy instantaneously all odors arising from animal or vegetable decomposition. It destroys germ life, all kinds of vegetable mold, and the eggs of insects and vermin. This preparation therefore arrests the spread of contagion in germ diseases.

No liquid preparation can do the work a powder can. Certain liquid preparations are offensive and irritating to the eyes, nose and throat; they are not absorbents or deodorants and are too dangerous for the public to use. Some are simply what is known as a caustic deodorizer, that is, they make a stronger odor, for a time, than the existing one. Such materials are often a menace to the public health, for a bad odor is nature's warning and should be destroyed, not merely concealed.

Nicine acts instantly and does the work required of it, because it immediately absorbs the existing odor and pre-



Construction of End and Center Frogs, For Small Angles.

vents further decomposition, hence, preventing further odor; it kills all mold, eggs and lavae, as well as all animal and vegetable micro-organisms.

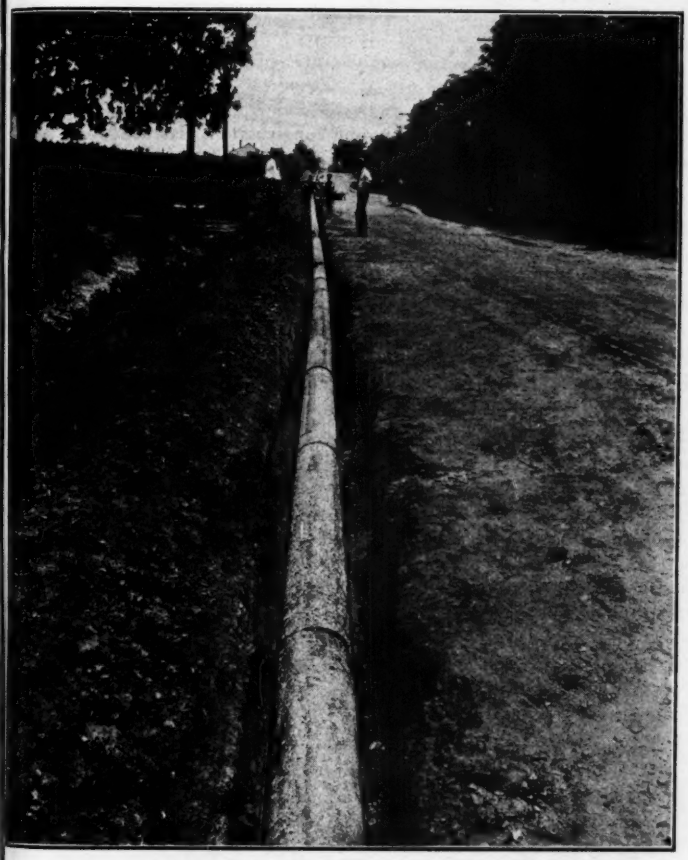
Railways have, in this preparation, an excellent material for use in cleansing and deodorizing passenger and refrigerator cars; for many uses in terminal and other stations, and in their commissary departments. It is not a new and untried preparation. It has been used and experimented with for years.

Nicine is supplied to the railway trade by the Tinsley Railway Supplies & Equipment Co., 1022 McCormick Bldg., Chicago .

WOODEN PIPES AND PIPE COVERING.

The Michigan Pipe Co. manufactures combination steel and wood water pipe, tin-lined wood casings for insulating underground steam and hot-water pipes, and creosoted wood conduits.

Herewith is shown an illustration of a line of wooden pipe which is now in use on the El Paso & Southwestern at Santa Rosa, Mex. The line is 76 miles in length and the entire water



Wooden Water Pipe Line on the El Paso & Southwestern.

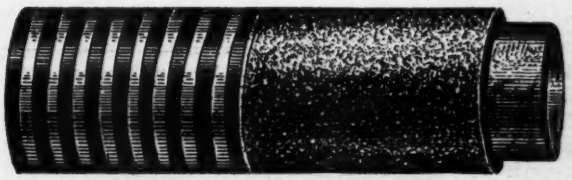
supply for the railway terminal is dependent on the line, which passes through an arid alkali desert. The piping withstood a very severe test after installation, and has since given absolutely dependable service under a hydraulic pressure of from 43 to 130 pounds per square inch.

The pipe is made in sections up to 12 ft. in length of best grade well-seasoned white pine and Michigan tamarack staves, which are machined on the sides, forming double tongue and groove, causing them to interlock and be mutually supporting. The inner and outer edges are dressed to conform to an exact curve, corresponding to the diameter of the pipe to be constructed. The staves are then thoroughly inspected and assembled in a cylindrical form, after which the sections are spirally banded with a heavy steel banding from end to end under heavy tension, thus making it of uniform strength and rigid as the solid log. A mortise is then put in one end and tenon on the other, so the sections can be easily driven together and the joint formed. The pipe is taken to the coating rolls, where the outside surface is covered with a thick layer of hot liquid asphaltum, rolled in sawdust on a sawdust table, placed back on the coating rolls to receive another layer of asphaltum and rolled again in sawdust. The pipe is then trimmed on the ends and cooled on rollers revolving in a bath of cold water.

The outside of the banding is absolutely protected by the double coating of imperishable waterproof asphaltum cement, which clings to the surface of the wood and steel alike.

With the strength of steel and the durability of wood, Michigan pipe attains the height of perfection for hydraulic use. It is practically a steel pipe with a wood lining. The steel banding is applied spirally with or without spacing, according to the pressure which the pipe must withstand.

Combination steel and wood water pipe has a number of advantages, compared with metal pipe. The wood will not corrode, is a non-conductor and will prevent water freezing, even if the pipe is laid nearer the surface than an iron pipe. When pumping, the wood acts as a cushion offering a variable resistance, or "breathing" with the action of the pump. No pits or flaws appear on the interior of a wood pipe, and vegetable matter is not caught as it smetimes is in a metal pipe, causing restricted flow. The lightness of wood pipe makes it much easier to lay, and no skilled labor is necessary. As wood is non-corrosive, and does not rot when constantly saturated, it will last indefinitely when used as water pipe.

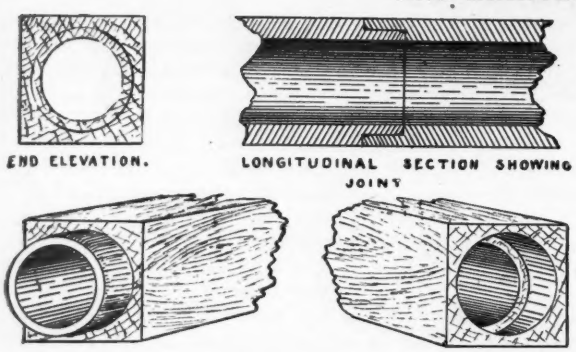


Construction of Wooden Water Pipe.

"Michigan" pipe differs from others in that this company lumbers its own materials, which gives a better selection of wood especially suited for the purpose. The pipes are all made with extremely accurate measurements, giving a perfect joint when the pipe is laid.

Wooden stave casings form an excellent insulating protection for steam pipes. The illustration herewith shows the details of this casing. The stave casings are made of best selected and thoroughly seasoned pine or Michigan tamarack, in sections up to 12 ft. in length. The inner and outer surfaces of the staves are curved to conform respectively with the inside and outside circles of the pipe and the sides are fitted with double tongue and groove running the full length of the pipe. The staves are thoroughly inspected and assembled in a cylindrical form, after which the sections are spirally bound with 3-16 in. galvanized wire from end to end under heavy tension with a double wrap at each end, giving uniform strength and the rigidity of a solid log. Smaller sizes of casings are made of solid logs bored and finished the same as stave casings. Pipe guides are used to hold the iron pipe concentric with the wood casing and also to allow for expansion and contraction.

Michigan creosoted wood conduits are used very advantageously for the protection of underground wires. The tubing is made in lengths of 8 ft. All the holes are finished with a reamer, making a smooth, continuous hole, allowing



Wood Conduit.

the cable to be drawn through without being caught upon offsets or projections. The joints are accurately centered so that there is no "lip" formed to offer obstruction. The following advantages are claimed for this conduit: It does not destroy insulation; it has but one joint in 8 ft.; the holes are straight and smooth; cables are not scratched in pulling them through; when struck with picks, only a hole the size of the pick is made; several joints can not be broken by a blow as in the case with some other materials; it does not require a concrete foundation; it will last forever; wires are reached between manholes more easily than in any other conduit; construction takes less time; it can be laid around immovable obstacles encountered in trenches, at the same cost per lineal foot as straight conduits; the creosote will prevent vegetable growth from reaching the conduits.

The wooden conduits, pipes and pipe coverings herein described, are manufactured by the Michigan Pipe Co., Bay City, Mich.

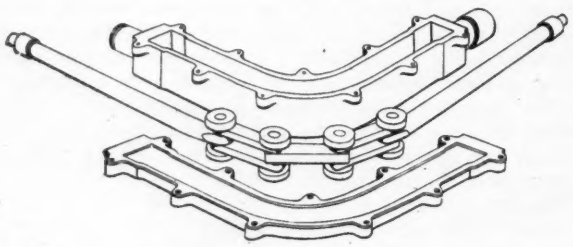
WILSON DEFLECTING BOX.

The W. K. Kenly Co., Peoples Gas Bldg., Chicago, has taken over the Chicago agency for the Wilson Deflector Box, made by the Wilson Railway Gate Co., Birmingham, Mich.

The Wilson Deflecting Box is designed to displace the bell cranks used in signal and other pipe lines for transmission of motion to a point distant from its source. The turns are made by means of short joints connected together by pins mounted in roller bearings between rollers. These rollers run on the inside of a water tight box which, after the connections are completed, is filled with a cold test oil.

When used for operating crossing gates the one-inch pipe which transmits the motion moves inside of a casing of two-inch pipe, the latter being connected to the ends of the deflecting box.

The Wilson Deflecting Box is made in acute, obtuse and right angles. The right-angle box is shown in the figure. An arrangement is provided also for a continuation of either of the straight line pipes past the deflecting point. The continuation is effected by a lug on the straight line pipe which is to be extended, this lug and the connection of the pipe extension working in a second box placed alongside the main deflecting box.



Wilson Deflecting Box.

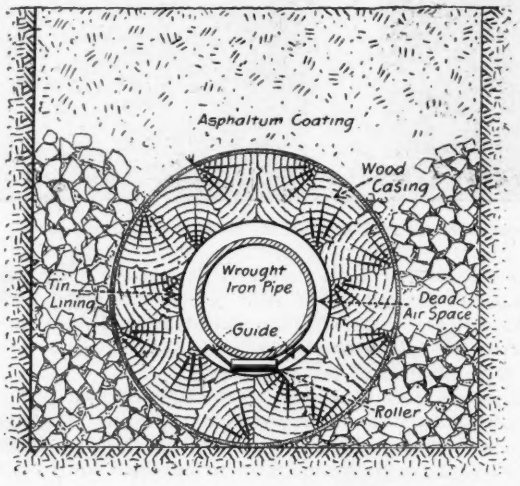
Laying Michigan Pipe Co.'s Wooden Conduit.

The W. K. Kenly Co. is the manufacturer of the Universal Pipe Line Carrier Base, for use at mechanical interlocking plants. This base is made of malleable iron in shapes and sizes to fit every condition of pipe line construction. Its use as a substitute for, and improvement on the old wooden type, is rapidly becoming universal.

The Baltimore and Ohio has authorized the erection at South Cumberland of new shops to cost between $3,000,000 and $4,000,000.

The Hagerstown Ry., Henry Holzaptel, Jr., President, Hagerstown, Md., is planning to construct a $250,000 power house. It will probably be located on Antietam Creek, two miles east of Hagerstown, Ind.

Two Chicago bridge bills were favorably reported in Washington by the Senate Committee on Commerce. One bill authorizes the City of Chicago to construct a bascule bridge across the Calumet River at 92d St. and the other authorizes the Lake Shore & Michigan Southern to construct a bascule bridge across the Calumet at South Chicago, to replace the present structure.



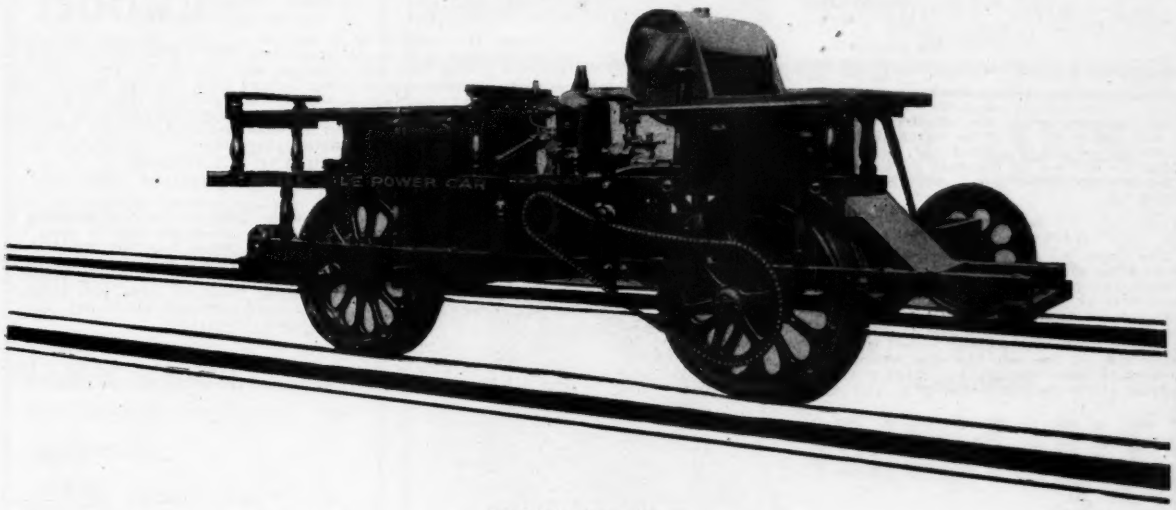
Michigan Pipe Co.'s Insulation for Steam or Hot Water Pipes.

BELLE ISLE MOTOR CARS.

The Concrete Form & Engine Co., maker of the Belle Isle Motors for attachment to ordinary railway velocipedes, now has on the market a complete car equipped with the same make of engine.

This car was designed by Mr. A. G. Stewart of the Kalamazoo Railway Supply Co., and is fitted with a powerful Belle Isle Motor. It is large, roomy, and comfortable. Although it is comparatively light and can be handled by one man, it will negotiate the steepest grades with ease.

A chain or belt drive can be used, connected either to the front or rear wheel. The car herein described may be seen at the exhibit of the Railway Appliances Association at the Coliseum, Chicago. W. D. Waugh, of this company, will be in charge of the exhibit of Belle Isle Motors and motor cars in the booth of the Kalamazoo Railway Supply Co., which is exhibiting an extensive line of railway equipments.



Belle Isle Motor Car.

The Kanawha Mine Car Co., Charleston, W. Va., is considering the construction of an addition of two buildings, one two stories, 60x100-ft. in area, the other one story, 58x55-ft. in area. They will be of reinforced concrete and will cost about $15,000.

Mr. Mark H. Kanary has resigned as general superintendent of the Des Moines Bridge & Iron Co., Des Moines, Ia., to become president of the newly-organized Rock Island Bridge & Iron Works. Mr. Kanary joined the Des Moines Bridge & Iron Co. in 1901 as superintendent and became general superintendent in 1907.

Ernest A. Sterling has resigned as forester of the Pennsylvania to open an office as consulting forest and timber engineer 1331-32 Real Estate Trust Bldg., Philadelphia, Pa.

Industrial Notes

The Atlanta Switch Co., Atlanta, Ga., has been incorporated to manufacture railway switches. The incorporators are Thomas C. Biggs, Roscoe F. Bishop and Paul Voss.

The Bucyrus Co., South Milwaukee, Wis., announces the appointment of Mr. Carl Horix as central sales manager in charge of the company's new office at No. 622 McCormick building, Chicago. A new office has also been opened at No. 707 Alworth building, Duluth, Minn., under the management of Mr. E. C. Hingston.

The Buzzards Bay Electric Co. is to install 78-in. Horizontal return tube boilers in its two electric plants, one at Falmouth and the other at Vineyard Haven. These boilers are now being built in the shops of the Robb Engineering Co. Ltd.

The Industrial Works(Bay City, Mich., is just completing the installation of a two-ton Tropenas converter plant having a capacity of eight to ten tons of castings per day. The company has made an extensive addition to its foundry and installed a complete equipment of saws and other accessories. It will make steel castings for its own use, however, and does not intend to enter the market with castings.

A meeting of stockholders of the Inland Steel Co. will be called in the near future to act on a proposition to increase the capital stock. The Inland Steel Co. is one of the most prosperous steel companies in the West. Its capital stock is $5,860,000.

John N. Reynolds.

The 1912 convention of the Railway Engineering Association is graced by the largest and most important exhibit in its history. The present high standing of the National Railway Appliance Association is due to the tireless work of certain of its officers. John N. Reynolds, its present treasurer, and who previously to this year performed the duties of both secretary and treasurer, has contributed in no small measure to the success of the organization, culminating in the 1912 exhibit. *Railway Engineering* finds pleasure in according credit where credit is due.

Recent Engineering and Maintenance of Way Patents

PATENTS.

NUT LOCK.

1,016,367—Paul C. Schmidt, Detroit, Mich.

The nut lock herein described comprises a threaded bolt and a nut for the bolt, the nut being formed with an opening arranged on a tangent to the bore of the nut and partially intersecting the bore; the locking pin is constructed of suitable material and comprises a body portion having a reduced extension; the pin when inserted within the bore is adapted to have its body spread or divided by the threads of the bolt, and the reduced extremity of the pin is adapted to be bent against one of the faces of the nut.

SIGNAL MECHANISM.

1,016,385—Walter P. Allen, assignor to The Union Switch & Signal Co., Swissvale, Pa.

This patent relates to a signal device nominally inclined to one position of indication, a fluid pressure mechanism comprising a cylinder and a piston having relative movement and one of which is operatively connected with the signal device, a source of fluid pressure, means for admitting the fluid pressure to one side of the piston whereby the signal device is moved to another position of indication against the force of gravity. Means are provided for cutting off the fluid pressure from the side of the piston whereby the signal device may return to its normal position of indication

RAILWAY TIE.

1,016,414—William H. Jones, Hudson, Colo.

The cross tie to which this patent relates has a rail fastening comprising a plate extending transversely beneath the rail to form a seat and projecting from opposite sides thereof, the plate being bent over at one of its ends to form an integral rail-holding clip adapted to engage the corresponding side of the rail. The plate on the other side of the rail is provided with an opening which registers with the groove; a rail-holding clip engages with the other side of the rail, the clip resting on the plate and having a downward bend through the opening and beneath the plane of the bottom of the plate into the transverse groove; a key passes transversely under the plate on opposite sides of the groove, and across the top of the bent portion of the clip; fastening devices are provided.

AUTOMATIC MAIL CATCHER.

1,016,478—F. E. Coyne, assignor to Sebree Mail Exchanging Device Co., Carrollton, Ky.

In combination with a car provided with a door opening, a rod extending horizontally across the door opening and being secured to the car side, a second horizontal rod secured to the car side near the top of the door opening, vertically alined blocks, one mounted on each of the rods, a net-carrying frame hinged to the blocks and adapted to close against the rods, an operating lever adapted to swing in a horizontal plane into the car and having pivotal connection to one of the horizontal rods at a point near the hinged connection of the net-carrying frame. A link is pivotally connected at one end to the operating lever near the pivotal connection of the lever with the rod and at its other end to the net-carrying frame near its hinged connection, the pivotal connection of the operating lever with the rod being located between the hinged connection of the frame and the pivotal connection of the link to the operating lever when the frame is in closed position.

GUARD RAIL.

1,016,525—N. E. Salsich, Harrisburg, Pa.

This guard rail extends adjacent the main rail and has alternating hollow and solid portions, the bottoms of the hollow portions being in the plane of the tops of the ties and the bottoms of the solid positions being above the plane of the tops of the ties. The guard rail has integral base portions resting on ties and extending beneath the main rail from the hollow portions of the guard rail.

RAIL JOINT.

1,016,621—H. G. Gilmor, Bath, Me.

The rail joint herein described is an automatically locking clamp comprising two jaws of unequal length, adapted to engage with surfaces of other bodies to exert pressure thereon, the longer of the jaws being provided with means adapted, automatically, to engage with surfaces of a body, when the clamp is forced into position, in such manner as to lock the clamp.

CATTLE GUARD.

1,016,636—V. E. Kent, Johnson City, Tenn.

The combination with a railroad track, of a cattle guard embodying toothed guard sections flexibly mounted to oscillate between some of the ties, and toothed stationary guard sections mounted on other cross ties and provided with oppositely disposed plates, extending downwardly in the direction of the flexibly mounted sections.

CROSS TIE.

1,016,806—V. B. Wheaton, Ionia, Mich.

A cross tie comprising a central or body portion, the body portion comprising a vertically straight web having off-set flanges. The ends of the body are enlarged, the ends of the body adjacent the upper portion thereof being formed with lips and having horizontally straight portions arranged below the lips. The ends of the body are formed with reduced extending portions, each of the end members having its inner portion enlarged and provided with lips adapted to overlie the horizontal portions.

MAIL CATCHER AND DELIVERER.

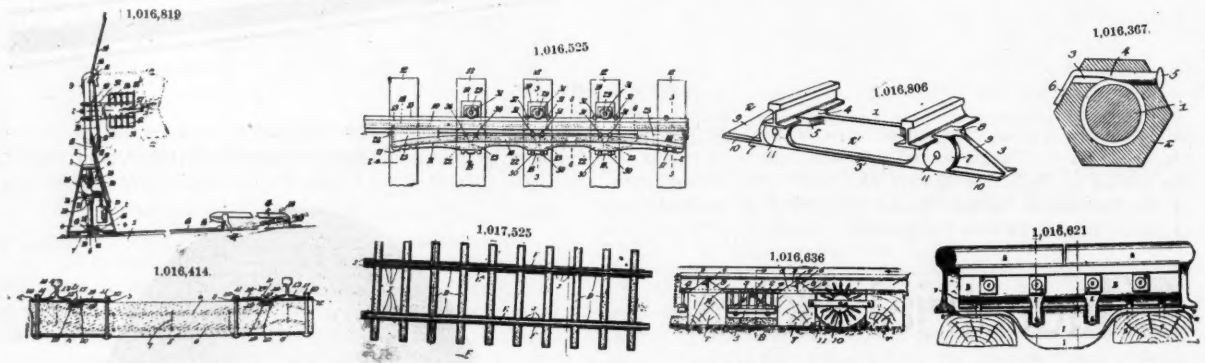
1,016,819—Benjamin Evans, Bluefield, W. Va.

A mail catcher comprising a rotating member, pivoted bag supporting arms carried thereby, means held in operative position to rotate the member in one direction when the bag is upon the arms, means to hold the member against rotation, train controlled mechanism for releasing the holding member, automatically actuated means for separating the arms and reversely rotating the member when the bag is released from the arms. and a catching device carried by the member and rotatable therewith.

TRACK CONSTRUCTION.

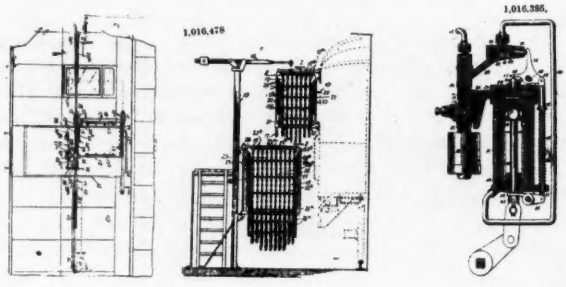
1,017,525—Walter Ferguson, Jr., Stamford, Conn.

An interchangeable monolithic unit section or element for a railroad track superstructure, comprising longitudinal and transverse metallic members incased in concrete or other cementitious material, the longitudinal metallic members being adapted to afford a practically continuous support or bearing for the rails throughout their length.



It is reported that the proposed subway under the Virginia Ave. crossing of the Baltimore & Ohio in Cumberland, Md., will be constructed in the near future.

The Canadian Pacific is said to be planning to carry out improvements at Ingersoll, Ont., including the construction of a bridge to cost $30,000.



New Dixon Railroad Booklet

We have just prepared a booklet treating of the various Dixon graphite products for use on the railroad. The entire Dixon railroad line is treated of and all other matters excluded—this booklet is of interest only to the various mechanical railroad departments.

The application of dry graphite for lubrication, the use of Dixon's graphite greases, Dixon's Silica-Graphite Paint, crucibles, facings, crayons, etc., is all included in this booklet—a total of 40 pages. There is bound to be some matter to interest you here.

We have tried to make our booklet attractive in appearance as well as interesting to read, and to this end have included views taken of railroad stations and yards, stretches of track, signals, bridges, etc.

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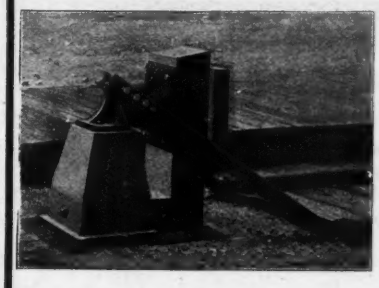

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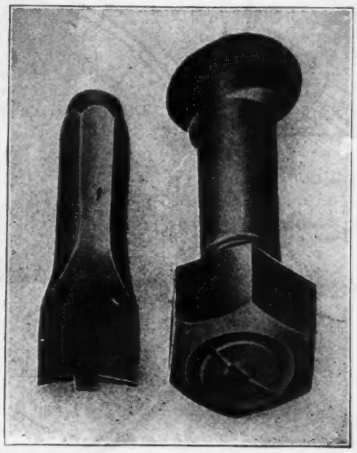

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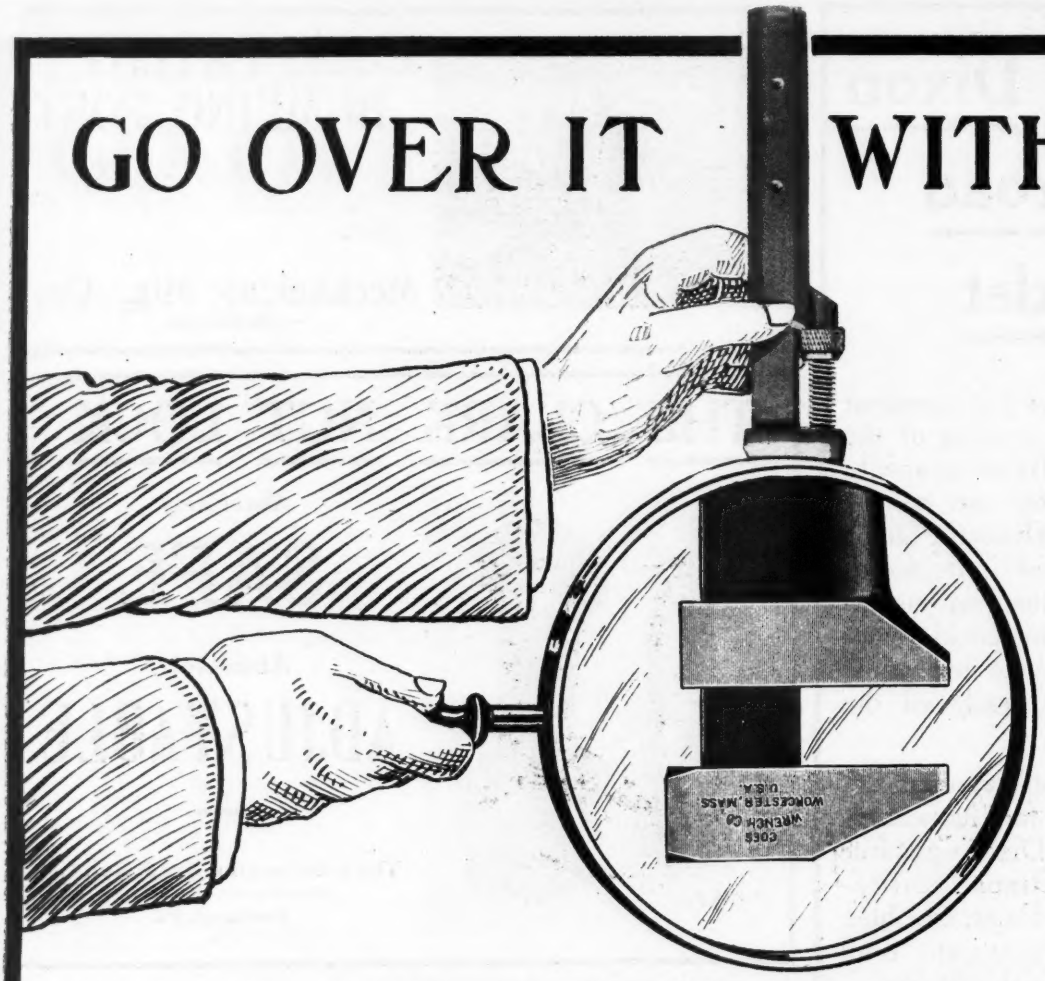

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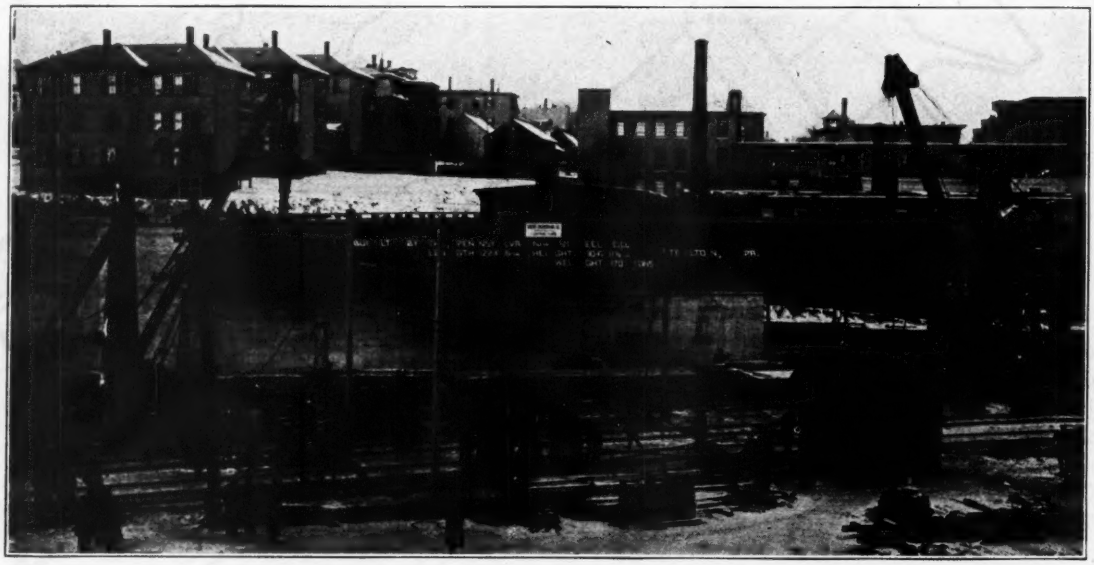

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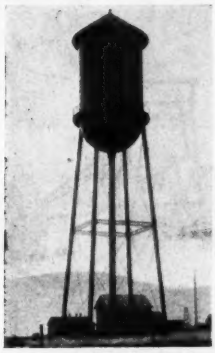
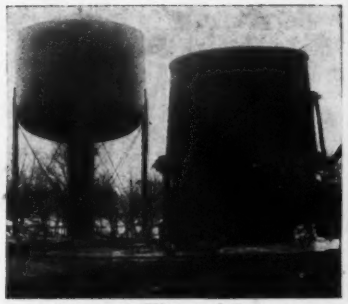


Standard Hemispherical Bottom Steel Tank



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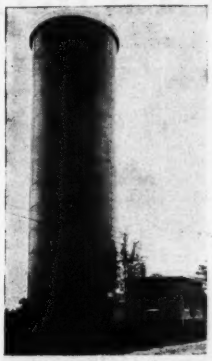
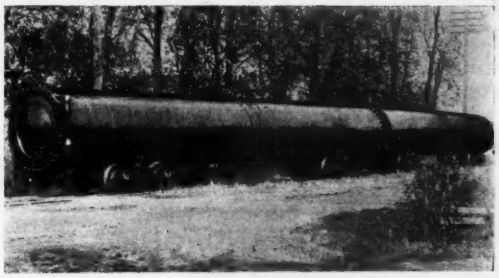
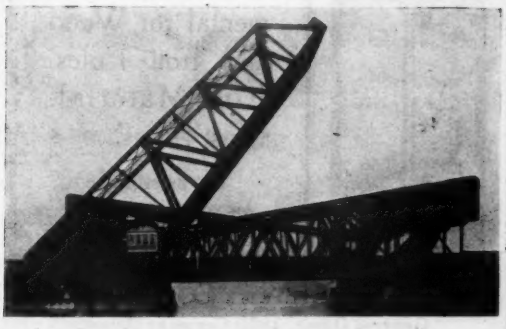


Steel Standpipe



Portable Tie Preserving Retort



Eight Track Scherzer Rolling Lift Bridge

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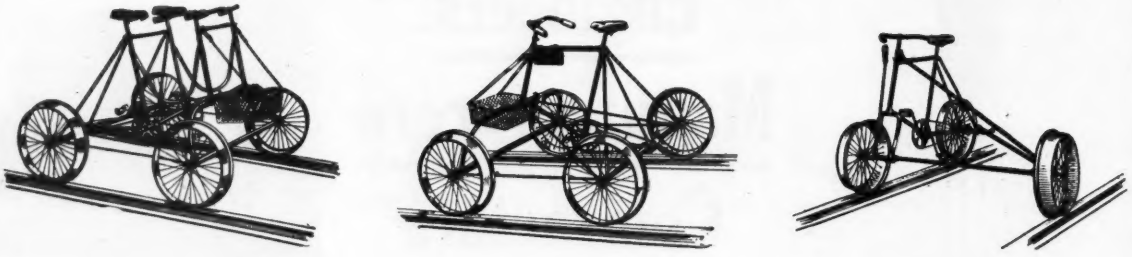

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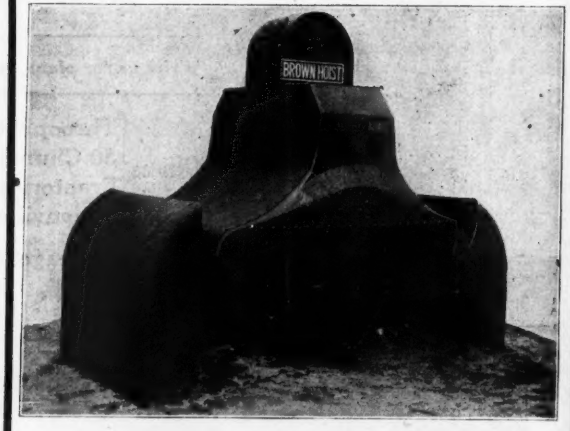

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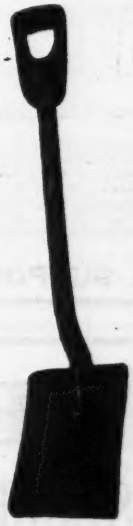
No. 68 STANDARD TRACK CHISEL

Shovels, Spades and Scoops

Track Shovels
Loco. Scoops
Coal Scoops
Charging Scoops
Ash Pan Scoops
Ore Shovels
Grain Scoops
Canal Shovels
Snow Shovels
Telegraph Shovels
Telegraph Spoons
Ditching Tools
Moulders' Shovels
Lime Shovels
Mining Shovels
Sidewalk Scrapers



STANDARD TRACK SHOVEL

WRITE FOR REPORT OF RAILROAD TESTS

WRITE FOR OUR NEW CATALOGUE

HUBBARD & CO.

NEW YORK 50 Church St. PITTSBURGH CHICAGO Fisher Bldg.

SELLING AGENCIES

BALTIMORE Weir & Wilson
BIRMINGHAM Solon Jacobs & Co.
DENVER Robt. J. Schlacks
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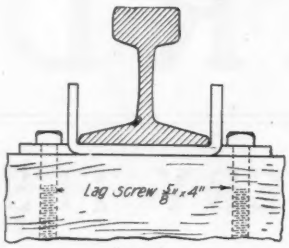
ST. LOUIS Genl. Ry. Matl. Co.
ST. PAUL H. H. McNair

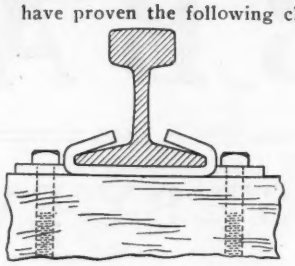
By a demonstration of over twenty months under both Passenger and heavy Freight traffic

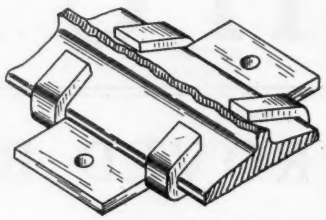
VAUGHN RAIL SUPPORTS

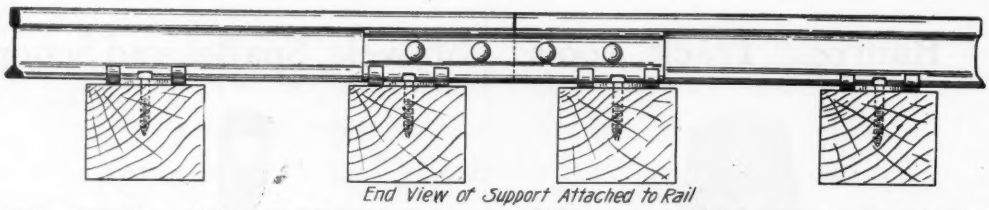
have proven the following claims:



Side View
Support Ready for Application


Side View
Support Applied


View of Support
Attached to Rail.


End View of Support Attached to Rail

No creeping, spreading or kinks. Supports do not loosen on tie or rail.
No deflection or mechanical injury to the tie.
No expense in maintenance since supports were applied.
Eliminates the purchasing of tie plates, because it is the best tie plate on the market, without its other merits.
Also eliminates rail braces, continuous joints, and anti-creepers.
It holds the rail absolutely in alignment either on Tangents or Curves.
It keeps your track to the exact gauge without the use of braces or other devices.
Preserves ties.
Permits the use of the less expensive class of timber.
It acts as an Anti-Creeper because it prevents wave motion of the track under traffic.
It avoids all possibilities of derailments due to rail breakage.
It does all these things, and at the same time costs no more than many tie plates now on the market, and is just as easy to apply.

VAUGHN RAIL SUPPORT COMPANY, Pierce Bldg., ST. LOUIS, MO.

YOU NEED "Track Standards"

A New Book full of up-to-date information for every member of the Maintenance of Way department. It should be in the hands of every trackman who is looking for advancement.

PROFUSELY ILLUSTRATED

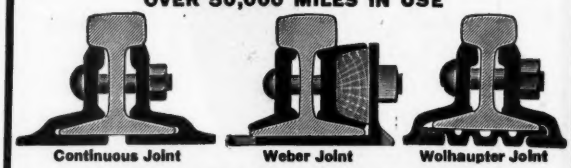
The Subjects Are

Roadway — *Switches, Turnouts, Etc.*
Ties — *Tie Plates*
Rail — *Cattle Guards, Fences, Signs, Etc.*
Rail Joints — *Derails, Rail Chairs, Etc.*
Rigid and Spring Rail Frogs — *Tools and Supplies*

Write us for special offer explaining how to get this book.

THE RAILWAY LIST CO.
MANHATTAN BUILDING CHICAGO, ILLINOIS

OVER 50,000 MILES IN USE


Continuous Joint — Weber Joint — Wolhaupter Joint

ROLLED FROM BEST QUALITY STEEL

The Rail Joint Co. General Offices: 185 MADISON AVENUE, NEW YORK CITY

Makers of Base-Supported Rail Joints for Standard and Special Rail Sections, also Girder, Step or Compromise, Frog or Switch, and Insulating Rail Joints, protected by Patents.

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Boston, Mass.; Chicago, Ill.; Denver, Colo.; Pittsburgh, Pa.; Portland, Ore.; St. Louis, Mo.; Troy, N. Y.

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and other
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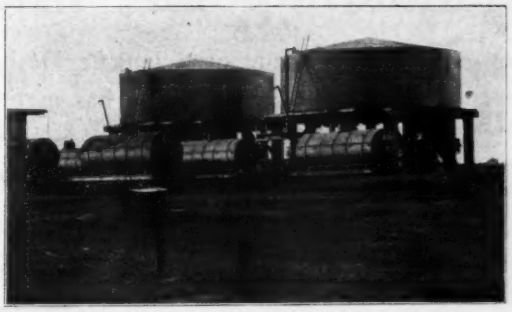
STEEL TANKS AND PLATE WORK

Water Softeners

GRAVER PRODUCTS

FAVORABLY KNOWN FOR

FORTY YEARS



Water Tower Tanks

Steel Water Tanks — Creosoting Tanks — Sand Storage — Culverts — Bridge Piers — Smoke Stacks — Oil House Tanks — Car Tanks — Stand Pipes — Car Wheel Annealing Pits — Pressure Tanks —

ALL KINDS OF TANKS FOR FUEL OIL BURNING SYSTEMS

1,000 to 20,000 Gallon Tanks in Stock. Immediate Shipment.

THE BARTLETT-GRAVER WATER SOFTENER HAS NO EQUAL

WM. GRAVER TANK WORKS, East Chicago, Ind.

DENVER, COLO. 1718 California Street

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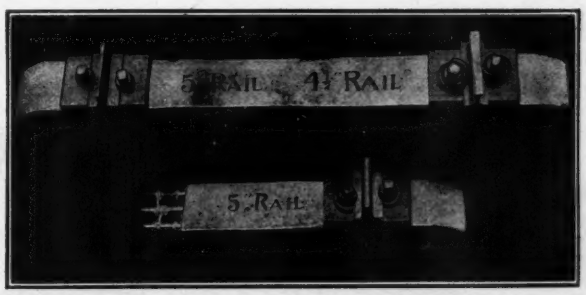
The Universal Concrete Tie

Note carefully the details of the spiking device and the peculiar "V" shape of the base of the Tie at the center, which insures an absolutely perfect alignment, obviates spreading of the rails, or the slewing of the track. The heavy hardwood cushions preserve the rolling stock as well as the tie; last for six to fifteen years, and are then almost instantly removed by the loosening of the screw spikes by one man.

The Percival Patents

In use under various Trunk Line Railways for five and six years past.



The above cut illustrates the Universal Concrete Tie.

For further facts and full evidence, address the

UNIVERSAL CONCRETE TIE COMPANY

1408-9 Whitney-Central Bldg. NEW ORLEANS, LA.

Trains are running sixty miles an hour over these ties, and have been so running for more than five years, yet they have had no repairs, realigning or even tightening of the spiking devices.

The reinforcement of our ties consists of four corrugated bars, the approximate length of the tie, and varying in size from 1-2 in. to 1 in. These are secured in proper shape by electro-welding the heavy binding wires. The truss core of the tie thus forming a complete unit within itself.

The best tie for terminals, because it is permanent.

The best tie for yards, because it is fire proof, rust proof, and will hold rails true to gauge.

The best tie for main lines and heavy traffic, because it is absolutely dependable under all conditions, as we can show in roads using them.

"Indianapolis" Manganese Track Work

is a composite of Scientific Designing and the Most Dependable Metal.
It has made good. Write us.

The special Features of our Designs have

REVOLUTIONIZED MAINTENANCE

and have been adopted by Leading Progressive Roads.

We were the Originators and introduced

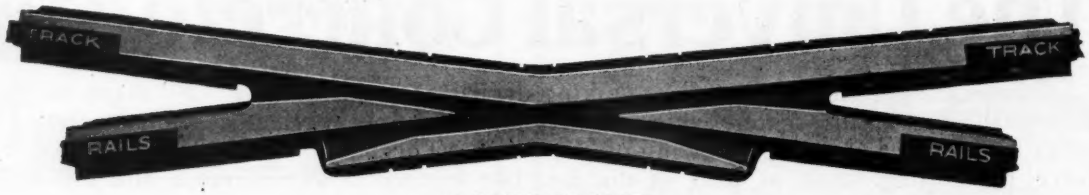
The first successfully designed *Solid Boltless* Manganese construction—Absolutely Dependable and Uniform.

and in which **Track Rails Connect with no Change Whatever.**
All "easer" protected.

"R-N-R" Manganese "Requiring No Renewals" that necessitates removing the work from the track during the life of the manganese, which Feature obtains in all of our Designs is worth your attention.

You have "Frog Crossing" Troubles—Here is the Cure

and it costs you nothing because the Saving in Maintenance alone will pay for them.



"A PAIR" OF EACH

The only expenditure necessary for a Frog Crossing.
Use your own connecting rails—Save 10 complete joints.
No open joints—No renewals—No spares to carry on hand.

We are showing at Armory Building, Exhibit Spaces 228-237

THE INDIANAPOLIS SWITCH & FROG CO., Springfield, Ohio

Sales Offices: NEW YORK CHICAGO KANSAS CITY SPOKANE PORTLAND SEATTLE LOS ANGELES SAN FRANCISCO

THE Merit of "Indianapolis" Products appeals to the discriminating *Engineer* and *Roadway Official*, who is progressive, practical and recognizes the value of Final efficiency and economy rather than low first cost with excessive maintenance and interrupted operating schedule.

He wants to know that all

Materials are strictly and absolutely first quality throughout.

Nothing but first quality rails and fittings go into any part of our product.

Nothing but American "**Stag**" Brand of manganese (the most dependable and serviceable metal of its kind yet produced) is used in our manganese work and in combination with scientific designing and liberal sections with a maximum safety factor—

Nothing is better (no exceptions).

He wants to know that

Workmanship and Methods are confined to the best modern practices only.

Our works are located at Springfield, Ohio.

We have every modern and improved facility for the most economical production of strictly High Class Product.

But employ no practices or methods to lessen the cost of production that are in any way detrimental to the steel or other material.

All rails are drilled—never punched.

All bolted structures are UNIT DRILLED and bolts a driving fit.

All rivets are compression driven—70 tons maximum pressure.

All manganese is accurately fitted and ground at a low temperature.

Result—Costs some more—worth much more.

He wants to know that

Design embodies strength and endurance and eliminates weakness and failures.

"**Conservation of Energy**" is a science which applied to Track and Rolling Stock has done more than any other one thing to bring into favor and recognition the "**Indianapolis**" Designs and their adoption by the leading and best roads in the country.

Our designs are the results of our own experience and observation together with a composite of suggestions of the most able Engineers and track men.

Designs that favor and protect both the structure and rolling stock.

Indianapolis built up designs of Regular Construction are reinforced and self-contained, prolong the life of the work.

Indianapolis R-N-R designs of Manganese Frogs and Crossings have revolutionized maintenance and when introduced were a radical departure from any known practice, yet have been freely adopted and are extensively in use on nearly all roads of importance where purchases are not restricted.

Indianapolis R-N-R Designs have features of exclusive merit not found in any others.

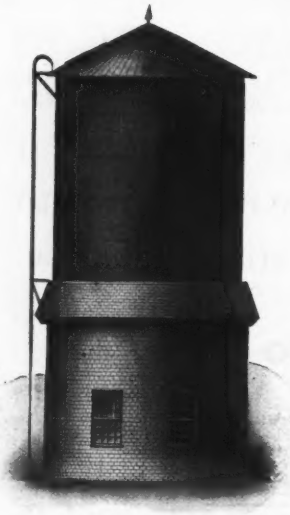
Indianapolis Manganese Designs of Insert Special Work, were the first to feature the renewal of rail parts without removing from the track for repairs.

He wants to know

where to get what he needs.

It is made at

Springfield, Ohio.



CONTINUOUS SOFTENER

Soft Water

a necessity for economical operation of boilers

INTERMITTENT SOFTENER

WATER SOFTENERS
Continuous—Intermittent

WATER FILTERS
Pressure—Gravity

PITTSBURGH FILTER MFG. CO.

Kansas City **Pittsburgh** **Chicago**

NICHOLS

GEO. P. NICHOLS & BRO.
OLD COLONY BUILDING :: CHICAGO

TURNTABLE TRACTORS TRANSFER TABLES

Our Electric Tractors are standard on more than fifty of the most important railroad systems in the United States, our standard equipment is complete in every necessary detail. Our Tractors are adapted to every class of service.

Our Heavy Standard Tractor is designed to handle the heaviest mallet locomotives and any locomotives that are too long to permit of being balanced on the table. Several of these Tractors are turning locomotives weighing over 300 tons.

We build engine haul equipments either mounted on the Tractor or to be installed separately. These are made to haul locomotives of any weight.

Our Electric Transfer Tables are known everywhere.

THE PRODUCTS OF THE

Kalamazoo Railway Supply Co.

are *standard* for ease of operation and durability

Kalamazoo Hand Cars

are equipped with the Kalamazoo Improved Reinforced Pressed Steel Wheel, giving 50 to 100 per cent greater wear than any other wheel of similar design or weight on the market. The car has stout gallows frame, thoroughly trussed, has taper wheel and pinion fits on axles, machine cut gears, flexible steady box and double acting brake.

16 Different Styles, Standard or Special

The Moore Track Drills

are made of selected materials, best adapted for their several purposes. The workmanship is first class and above criticism. The spindle has a ball thrust bearing, especially designed to relieve the friction. All bearings are designed to give durability.

Any style, over-clutch or under-clutch, as desired.

The Jenne Friction Jack

has steel pivots, bronze boxes, malleable iron frame and lever socket, wrought iron rings, hanger and lifting bar. All parts replaceable from catalogue.

Three sizes, adapted to all classes of track work.

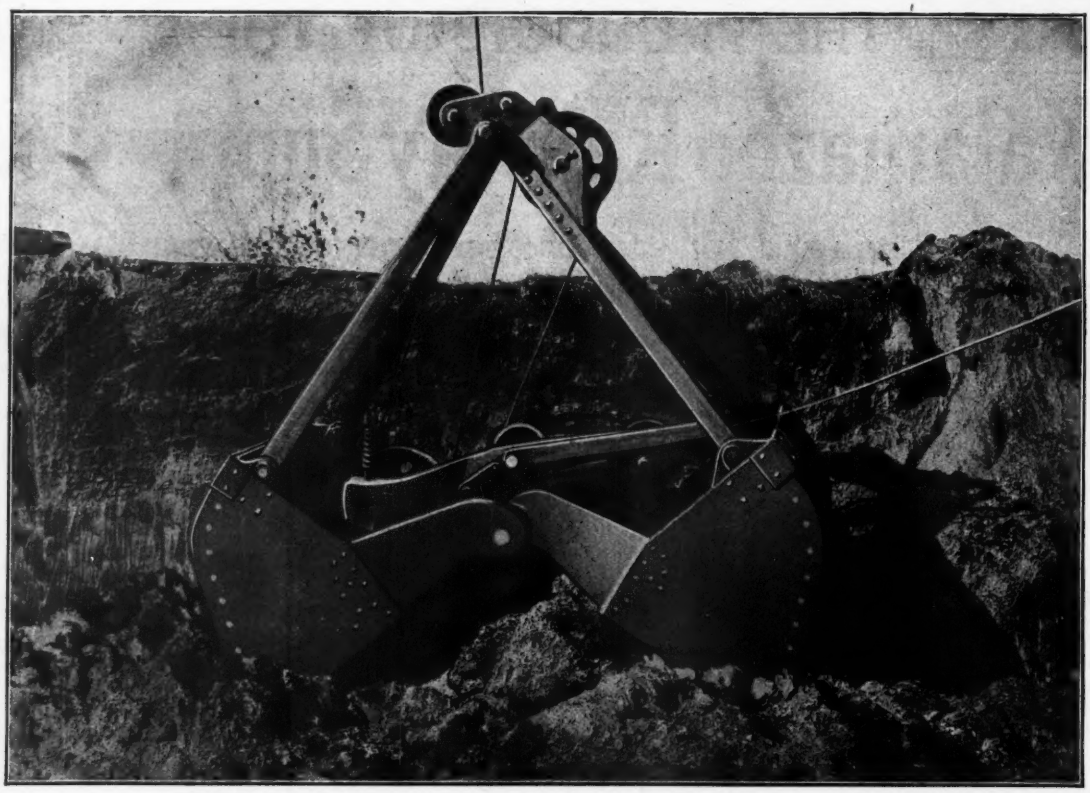
Catalogue of Track and Railway Supplies on Request

Kalamazoo Railway Supply Co.

MANUFACTURERS

KALAMAZOO, MICH.

Western Representative: W. K. KENLY COMPANY, Chicago



View of a **Williams No. 2 Single Rope Bucket** used for quarry stripping near Minneapolis, Minn., showing bucket partly closed, filling itself with material consisting of sod, clay, loam bowlders, etc.

THE

WILLIAMS No. 2 SINGLE ROPE BUCKET

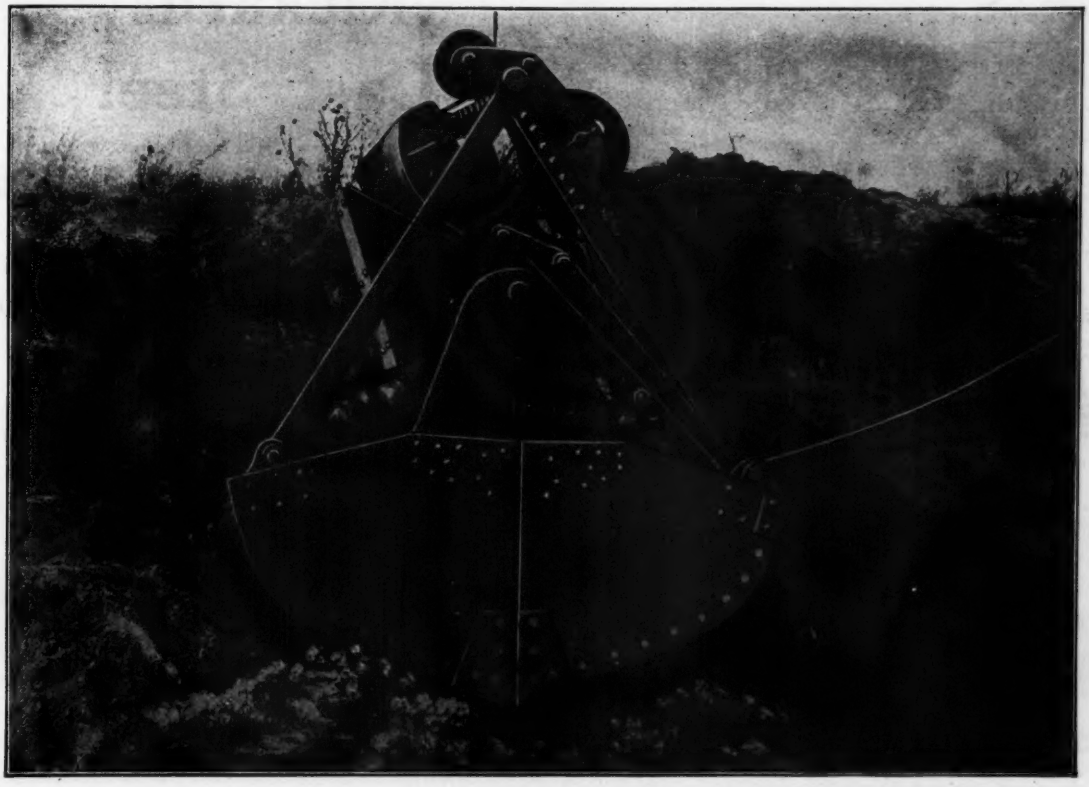
Was especially designed for and has proven to be

The Contractor's Friend

Can be used on any hoist or derrick for excavating, dredging or pier foundation work, and for handling sand, gravel, crushed stone and other materials of like nature

The G. H. Williams Company

ROCKEFELLER BUILDING ∴ · ∴ CLEVELAND, OHIO



Closed view of bucket shown on opposite page, filled with earth and ready to be hoisted and swung to dump, where load is dumped by a slight pull on the hand line (shown leading to right side in cut).

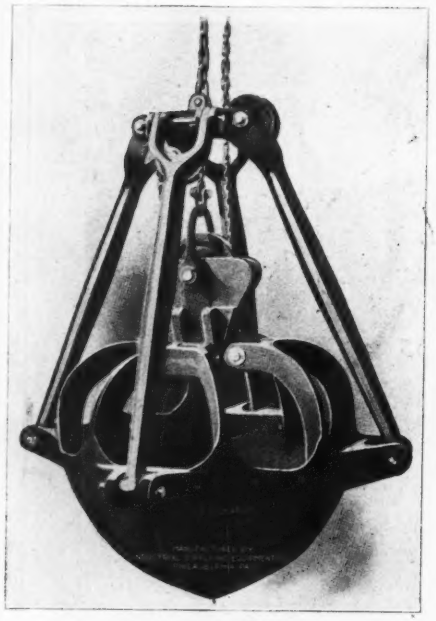
This bucket is closed, hoisted and lowered by means of but one hoist rope, and the load is dumped by a slight pull on a hand trip line, which may be operated by the engineer. The bucket may be hoisted either open or closed, and the trip rope may be pulled during any stage of its operation.

These buckets are an all-steel construction with large bearings throughout. The steel sheaves are finished wire rope scored, bronze bushed and bored to turn on pins of large diameter. Ample means for lubrication is furnished throughout, and buckets are built in best workmanlike manner, and are ready for immediate service when delivered.

WRITE FOR INFORMATION AND PRICES

The G. H. Williams Company

ROCKEFELLER BUILDING CLEVELAND, OHIO



Rickards Cast Steel Orange Peel Buckets

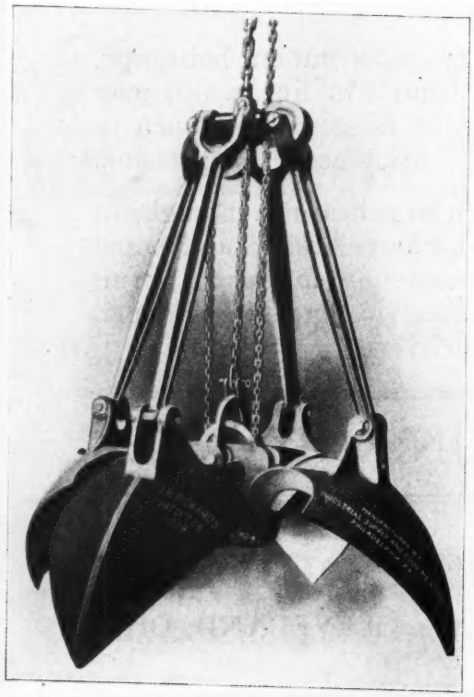
The Bucket for Hard Service

Rickards Orange Peel Buckets are constructed with four curved triangular cast steel blades, and when closed form a tight semi-spherical bowl, which holds the excavated material.

Rickards Bucket parts are interchangeable and are numbered and lettered. Reference to the number of the bucket being all that is necessary in ordering any part.

The Center Block is made of cast steel and fitted to carry and allow the bucket to hang central at all times.

All buckets are fitted with chain wheels, as this construction has been found more desirable. Buckets to be operated by wire rope will be furnished if so ordered.



The Rickards Orange Peel has been so designed that three sizes of blades can be used on the same crown rigging. That is, you can buy say a 1 yard Bucket and also buy ¾ yard and 1¼ yard blades for same rigging.

The Industrial Supply And Equipment Co.

407 Sansom Street, Philadelphia

AGENTS:—J. H. Allen, 2 Rector Street, New York City; Willis Shaw Machinery Co., 39 S. LaSalle St., Chicago; W. H. Dayton, Security Building, St. Louis; J. M. Van Harlingen, Chandler Building, Atlanta; A. H. Van Winkle, 160 Beale Street, San Francisco; L. W. Miller Co., Boston.

EXCAVATING BUCKET

BEST ON EARTH

Standard Bucket Type "C" Closed

These

BUCKETS

are the

Standard Bucket Type "D" Closed

Most Durable Buckets Made. Built Entirely of Steel

IN ALL SIZES

A BUCKET FOR EVERY SERVICE

Write

THE G. H. WILLIAMS CO.

CLEVELAND, OHIO

Single Rope Bucket Closed View

FOR

INFORMATION

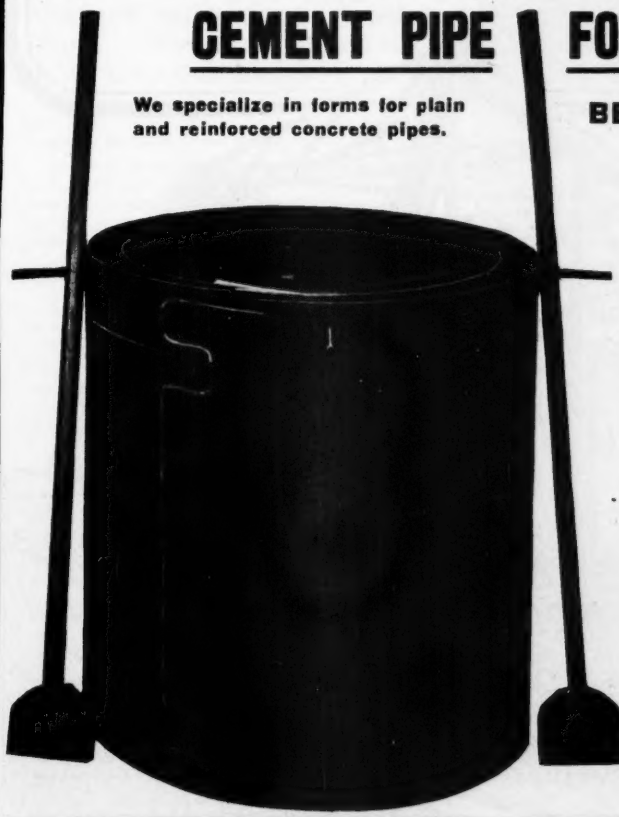
and

PRICES

Single Rope Bucket Open View

CEMENT PIPE FOR CULVERTS

We specialize in forms for plain and reinforced concrete pipes.



BELL MOUTH

or

GROOVE and TONGUE

Cheap, Durable, Strong

All Sizes

Diameters, 1-5 feet

Length, 2-6 feet

Any thickness of wall

State your requirements and prices on forms and reinforcement promptly furnished.

MARSH CO.

Old Colony Bldg. - CHICAGO

RAVAGES OF RUST

You realize the foolishness of leaving steel unprotected, you know how quickly it yields to rust.

To apply a paint that only offers "fair" protection is, however, merely a step in advance of no protection—the very best paint is never too good for the expensive steel structure.

Dixon's Silica-Graphite Paint

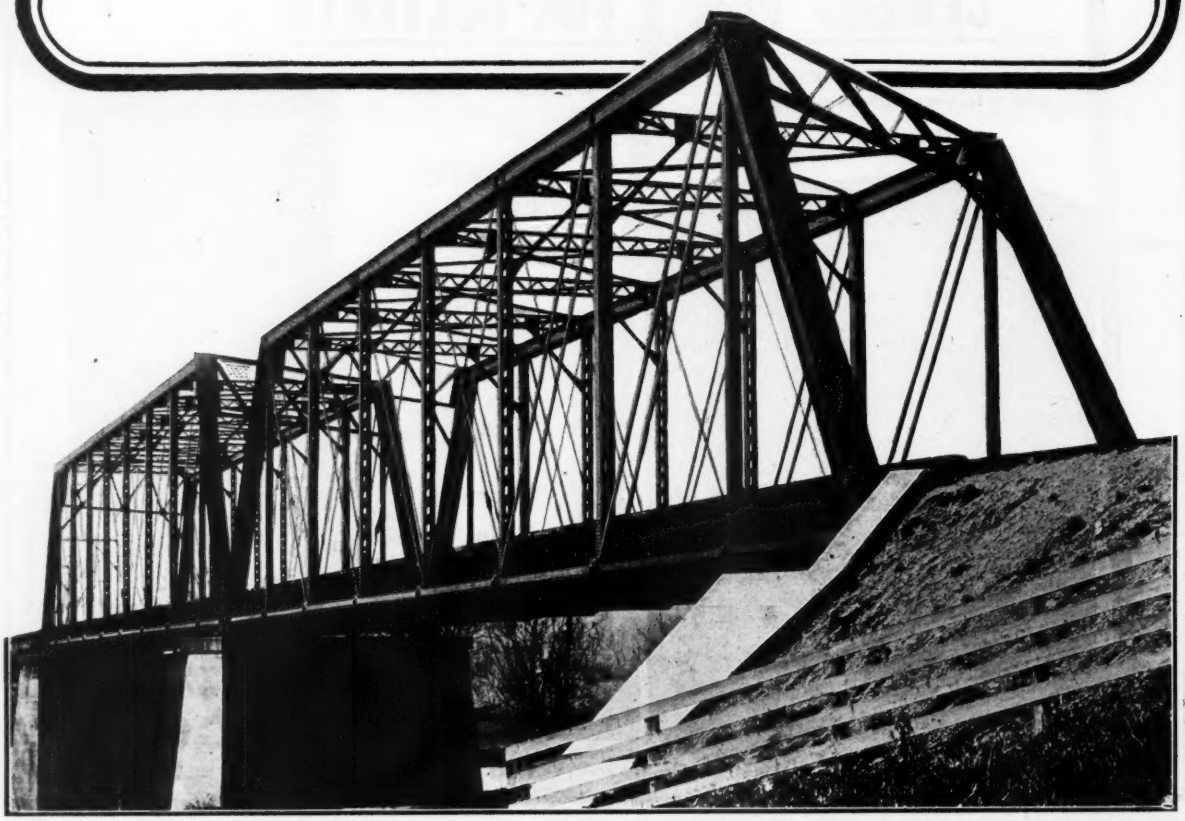
resists the ravages of rust and offers good protection to the steel structures for long periods. It is capable of this protection because it is "designed" to meet the particular needs of protective service. Dixon's does one thing and does that one thing well—it protects.

The "reason" for the service given by Dixon's Silica-Graphite Paint is found in the inert pigment, silica-graphite, and the pure linseed oil vehicle.

Write for "Colors and Specifications"—a new edition.

JOSEPH DIXON CRUCIBLE COMPANY

JERSEY CITY, N. J.



STOP!

Here is an up-to-date device for the up-to-date man.

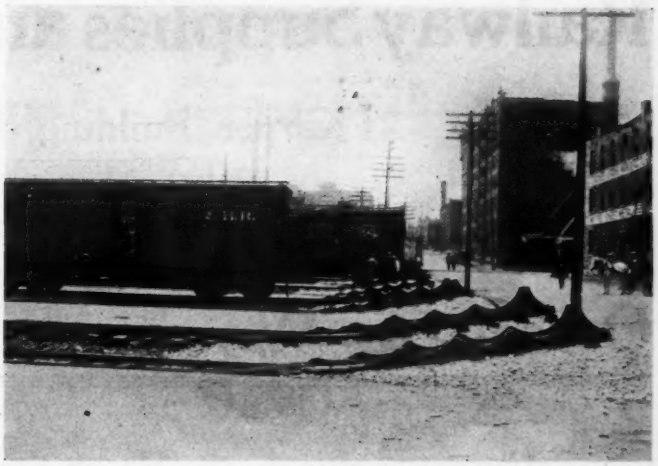
Save yourself trouble and expense.

No more broken posts.

No more maintenance cost.

No more damage to equipment.

Let us prove its worth to you as we have to others.



THE Saunders Car Stopper is not a theory, but a tested, effective and economical device. Over one hundred railroads are using them. One road alone has more than one hundred.

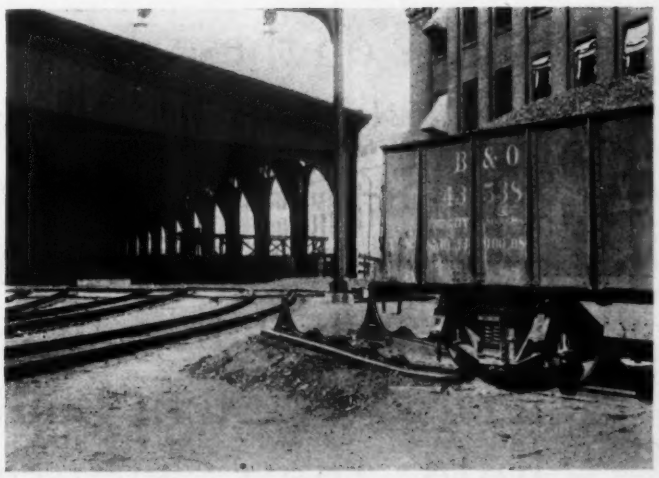
This stopper will stop anything that the patented rigid posts will, but without damage to either car, contents or stopper.

Have you ever had a car standing close to a rigid post when a forced coupling was made? Wasn't there a great strain on both the car and post? And in time hasn't that post been knocked out by a very light impact? Why not avoid all this by using the Saunders Stopper?

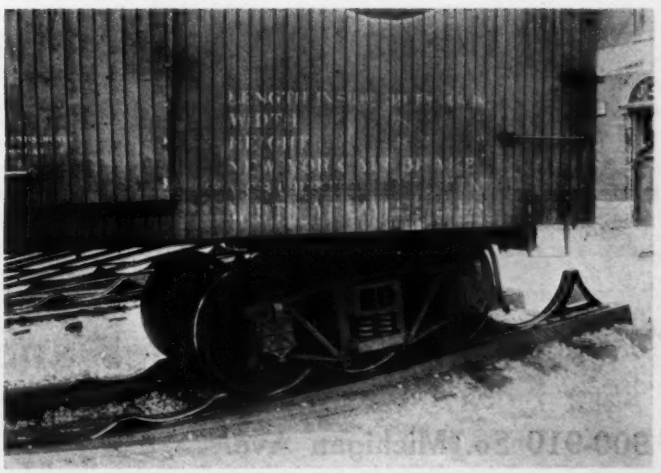
They are so cheap that you should not be without one at every open end track.

The engineer can tell the moment he touches the first corrugation—which enables him to stop *at once*. With a rigid post he cannot "feel" the end of the track until he hits it.

The stopper requires *two feet more* space than the average post, *but* you can use at least five more feet, if necessary, by pushing the car back on the stopper.



Let us explain our
TRIAL PROPOSITION



SOUTHERN RAILWAY SUPPLY CO., ST. LOUIS U. S. A.

Manufacturers' Exhibit Railway Supplies and Equipment

Karpen Building, Chicago

Opening Week March 16 to 23

Exposition will be open to the public on these dates. Special entertainment will be provided for visiting railway men. All are invited. Tickets of admission can be had by addressing the secretary. Western Railway Club will hold their monthly meeting Tuesday, March 19, in the Exposition Assembly Rooms.

Manufacturers' Exhibit

Railway Supplies and Equipment

900-910 So. Michigan Ave. **Karpen Building, Chicago**

Banks Signal Cell, R.S.A.

1912 Model

Banks Track Circuit Cell

N-W Binding Post

are shown at SPACE 4 of the NATIONAL RAILWAY APPLIANCES ASSOCIATION HELD IN THE COLISEUM IN CHICAGO.

For further information on the above
Address SOLE SALES AGENT

NorthWestern Construction Company

Hudson Terminal Building :: 50 Church Street, New York

JOHNSON CAR REPLACERS

Types Z, A or B, left hand

In general use by

Standard and Logging Railroads Mines and Contractors

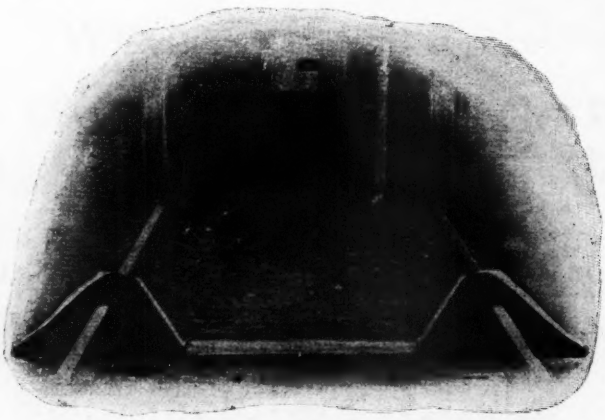
Types C and M, right hand

THE JOHNSON FROG:

Straddles the rail—needs no spikes, clamps or fasteners
Rests on rail both front and rear
Adjusts itself to different heights of rail
Forms a friction grip with rail during the operation
Brings rails to gauge during replacement
Distributes the load on the rail and tie
Special types for Steel-ties and Street Car rails

	Range	T. Rail	Capacity	Throat opening	Wgt. each.
Type M	for rail 12 - 45 lbs.	if not over 3½ inches high	20 Ton Locomotive	2 inches	30
" C	" " up to 65	" " " 4½ " "	30 " "	2½ "	60
" B	" " 80	" " " 5 " "	50 " "	3¼ "	110
" A	" " " " 100	" " " 5½ " "	80 " "	3½ "	145
" Z	" " " " 100	" " " 6 " "	100 " "	3½ "	165
" AA	" " " " 100	" " " 6 " "	200 " Wreck Outfit	3½ "	275

Will De-Rail also



30 Days Trial Free

After Rerailing 50 Ton Car

THE JOHNSON WRECKING FROG CO.

CLEVELAND, OHIO

The Trackman's Helper

Revised Edition

by J. KINDELAN

A Practical Guide for Track Foremen

Thirtieth Thousand

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"I find the Revised Trackmen's Helper the most generally instructive and useful book for trackmen that is now obtainable. I think every Track Foreman and Roadmaster should have a copy of it."—*D. Sweeney, Roadmaster, C., R. I. & P. Ry.*

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This book is written especially for practical trackmen who desire a guide so that they may become better acquainted with the elementary principles of railway curves and to enable them to adjust their curves satisfactorily independent of the civil engineer. All complicated formulae or calculations have been omitted in order to produce this practical work.

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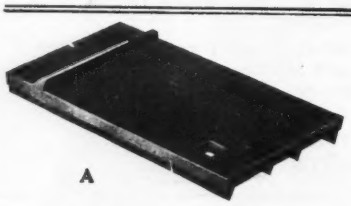

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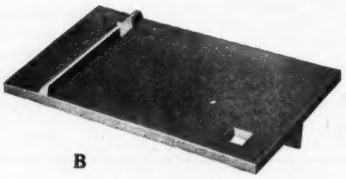

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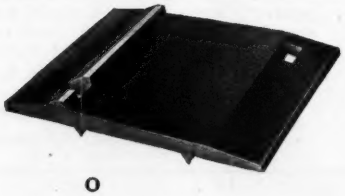

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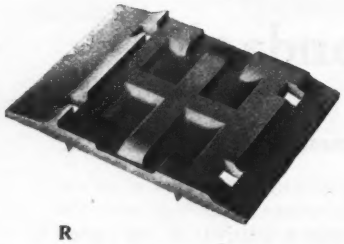

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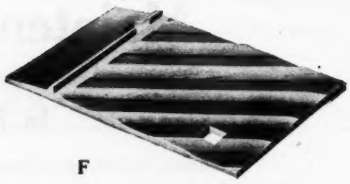

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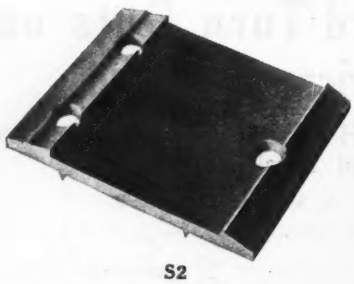
Six Different Types

To Meet the Requirements of American Engineering Conditions



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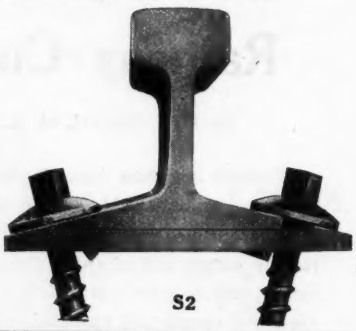
This Inclined Screw Spike Plate is designed to furnish *wide Surface Contact* between the head of the Screw Spike, Rail and Tie Plate. Has but one shoulder, to permit easy removal of rail.



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Plates Manufactured by the Elyria Iron & Steel Co.

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Elbert Hubbard has written entertainingly on "How to get others to do your work." He tells about a General Manager who stepped into a freight office one morning while on an inspection trip and asked for the agent.

"I am the agent," said a young man.

"Where's your desk?" said the G. M.

"I don't have any desk; I just have others do my work."

"By the eternal you're the first real man I've seen since I shaved this morning. I'll make you a superintendent," said the G. M.

Mr. Hubbard points the moral that executive ability is always above par.

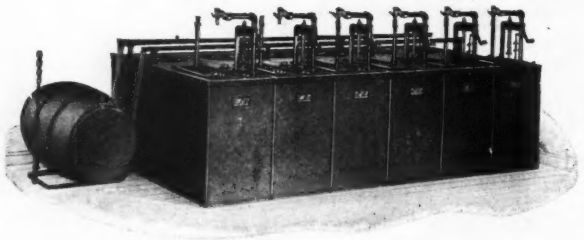
The successful railroad officer organizes his men to do his work for him but he does not neglect to provide them with proper tools and materials.

Equip your line with Hayes Derails and see how much more smoothly it is operated. The danger of intruding cars at turnouts is gone. The constant attention and other troubles of the switch point derail are forgotten; the energy needed to take care of this makeshift may be expended in useful channels.

The Hayes Derail will do your work faithfully; its presence on your line indicates an organization efficient both as to men and materials.

Hayes Track Appliance Co., Richmond, Ind.

Bowser Railroad



Cut No. 64.

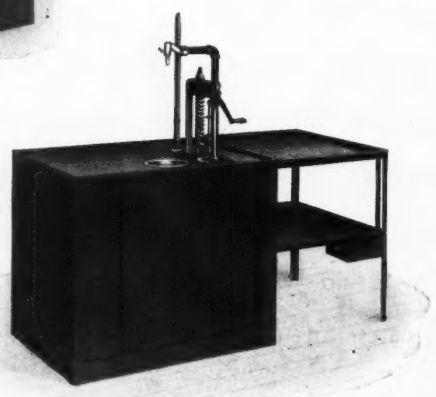
The Bowser Cut No. 64 for lubricating oils is designed for "battery" installation, i. e., the tanks are all the same length and height, varying in width to make the desired capacity. This permits the use of track so barrel can be hoisted and rolled over any tank.

The large manholes allow access to the tank for filling or cleaning. The pump can be set to exactly fill oilers if the capacity is not more than a quart. A single tank can be installed if desired and added to as conditions require.

Cut No. 52.

The Cut No. 52 illustrates our all-steel roll top lubricating cabinet. The pump measures a quart, pint, or half-pint or any intermediate quantity.

It is dust and dirt proof. It is usually made in one and two barrel capacities. Especially convenient for engine and lathe rooms.



Cut No. 37.

The Bowser Cut No. 37 Table Tank was designed for railroad requirements in filling and cleaning switch lamps. It is a combination storage tank for signal oil and a table for cleaning, filling and trimming switch lamps.

The pump is self-measuring and can be adjusted to fill at one stroke the different lamps. All dirt, water, oil, etc., on the table drains into a receptacle for that purpose shown in cut.

¶ Railroad expense is an important question to every railroad official and is great enough even when it is minimized. The rapid development in railroad lines in the last few years is due very largely to bringing every detail of the business up to its highest standard of efficiency.

¶ Realizing the marvelous advancement railroads have made in practically every department it is curious to note that so little has been done to facilitate and economize the storage and handling of oils.

¶ On account of the great number of places oil is used on railroads and the consequent opportunities for loss it offers a vast field for investigation and reduction of expenses.

¶ S. F. Bowser & Co. Inc., have spent twenty-six years in solving this question of oil storage and distribution. Every possible contingency in this line has been met and a system designed to meet it.

¶ Railroads do not distribute pay to the employes without keeping an accurate record of the amount so expended. Why do they distribute their oil throughout the entire system without keeping an adequate check on it?

A request for Bulletin No. 1-J of Importance on

S. F. Bowser & Co., Inc.

New York Boston Chicago Philadelphia Toron

Oil Storage Systems

¶ The Bowser System furnishes a complete record of oil received and where it went—no guess work—you know just how much oil has passed through the pump and your records show what it was used for. Some one is held accountable and he will see that oil is not issued in excess of requirements.

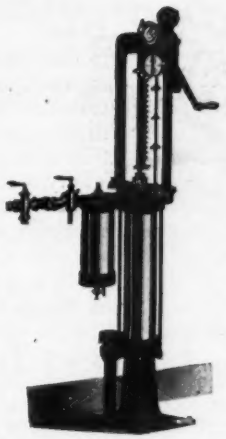
¶ We quote the following from a report made by a railroad using one of the largest storage systems we ever installed: "We have the Bowser system of self-measuring and metering pumps at all points and since their installation we have been able to show a slight overage in each of the different grades of oil. Prior to this time we were, at the end of each year, from one to three per cent short." This report was read at the convention of the American Railway Bridge and Building Association held in Denver, October, 1910. (See proceedings of twentieth convention page 141.)

¶ In view of this statement of facts made by an official of one of the largest railroads in the country after testing the efficiency of a Bowser System there is no logical reason why every railroad should not use a System.

will bring more information railroad storage.

Fort Wayne, Ind.

Atlanta Dallas Minneapolis San Francisco St. Louis



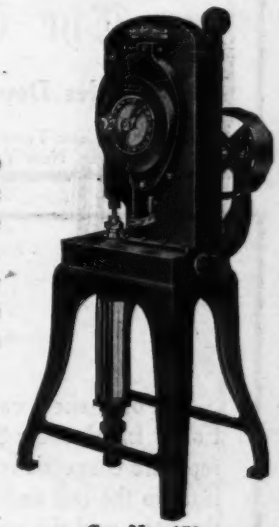
Cut No. 41.

The Cut No. 41 is the standard Bowser Long Distance pump which discharges a gallon, half-gallon, quart or pint at a stroke. It is used with many of the Bowser storage tanks and will handle any liquid any of the other pumps will handle.

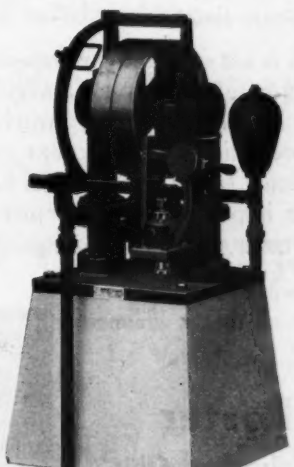
It can be located at any convenient place any distance from the tank—is fitted with a lock and discharge register, can be fitted with 5,000 gallon meter.

The Bowser Power Pump Cut No. 150 can be belted to a line shaft, electric motor, gasoline engine or other source of power.

It can be set to pump any quantity from one to 1,100 gallons and when the quantity for which it is set is pumped, it automatically stops.



Cut No. 150.

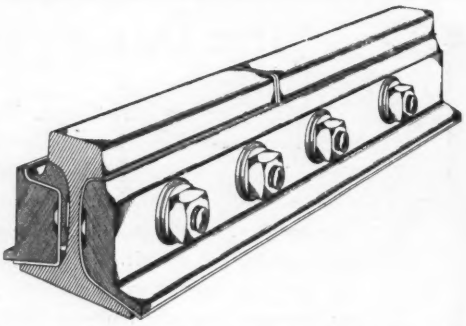


Cut No. 704.

The Cut No. 704, known as the double plunger pump, is designed for handling heavy, light and volatile oils. It is semi-automatic (started by hand and automatically stopped by back pressure by closing valve at point of discharge). It can be either belt or electrically driven. Designed for rapid transferring of oils—made in several sizes.

The KEYSTONE Insulated RAIL JOINT

Exhibition Spaces 40 to 43, National Railway Appliances Ass'n. Exhibit



One of the most important elements in a track circuit is the insulated joint. An efficient joint should hold the track in surface and alignment and must keep down current leakage.

The ideal insulated joint would be everlasting. Most insulated joints are far from this. THE KEYSTONE JOINT is the nearest approach to the ideal yet produced. All its parts except the fibre insulation are of rolled steel. It is stronger than the non-insulated joint. Its absolute rigidity enhances the life of the fibre and keeps down maintenance cost. The construction of the joint provides for a maximum amount of bearing on the insulation per square inch with a minimum amount of pressure.

THE KEYSTONE JOINT maintains its proper spacing between rail ends allowing the non-insulated joints to open uniformly when rails contract, avoiding the wide openings so common at insulated joints during cold weather.

The service these joints are giving is demonstrating daily that the KEYSTONE is the cheapest and most efficient joint on the market considering performance as well as price.

STANDARD ON A NUMBER OF LEADING RAILROADS WHO WERE CONVINCED BY SATISFACTORY RESULTS.

TRADE MARK **The Union Switch & Signal Company** TRADE MARK

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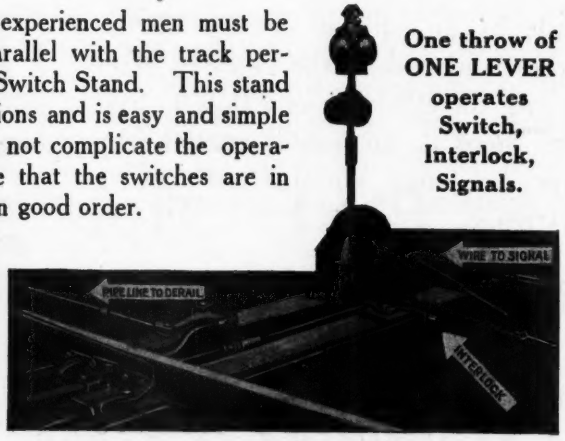
FOSTER

Interlocking Switch Stand

You make a careful inspection of switches to see that they hold the points up to the rail. The Foster Interlocking Switch Stand guarantees the points to be up to the rail and secured with two separate connections from the points to the ties. The lever will not enter the latch until the point is up to the rail and bolt locked. If there is lost motion in the connections or an obstruction between the point and the rail the lever cannot be forced down into the latch. With this stand the points must be kept adjusted within safe limits to be able to operate the stand.

Any track device which is not operated by experienced men must be simple and positive. One throw of one lever parallel with the track performs all operations with the Foster Interlocking Switch Stand. This stand guarantees safe switches between times of inspections and is easy and simple to operate. It provides additional safety and does not complicate the operation of your switches. Your inspection is to see that the switches are in good order and this stand is made to keep them in good order.



One throw of ONE LEVER operates Switch, Interlock, Signals.

Foster Interlocking Switch Stands have been tested in service and do all that is claimed for them.

Frank M. Foster

515 W. First Ave., Columbus, Ohio

The American Railway Signal Company

Is a LEADER in improvements in the Design of Signaling Apparatus.

Our Automatic Block Ground Signal has been in use for 7 years with an unparalleled record—

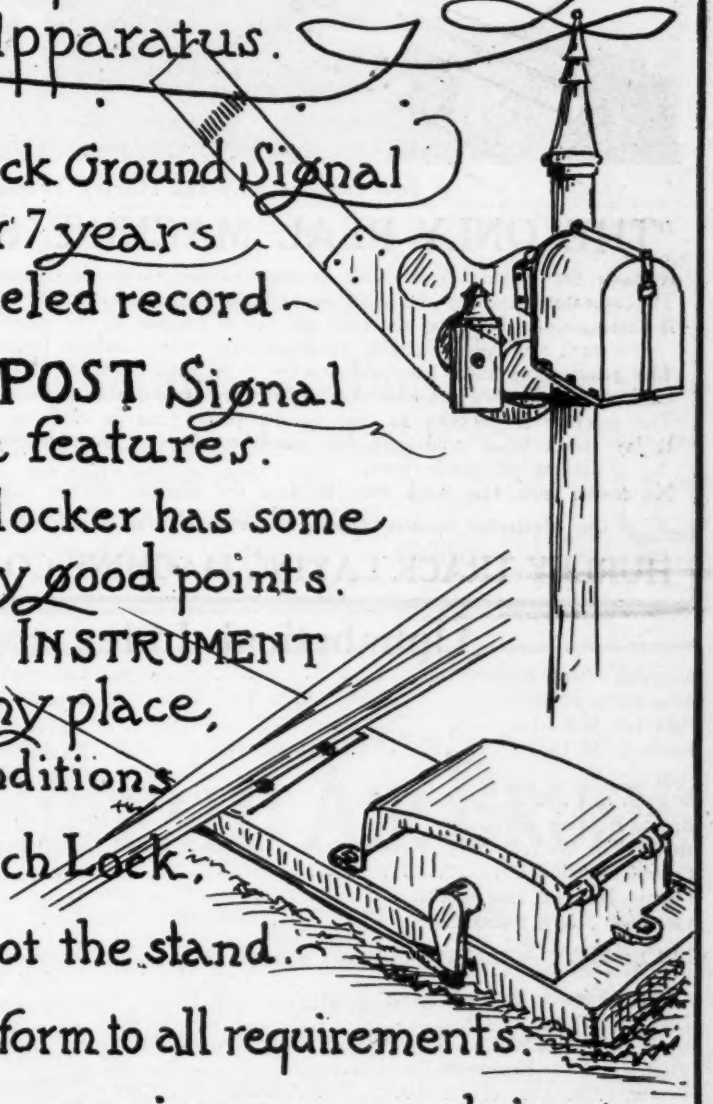
Our NEW TOP POST Signal has some unique features.

Our Electric Interlocker has some NEW and peculiarly good points.

Our NEW SWITCH INSTRUMENT can be used in any place, and under any conditions.

Our Electric Switch Lock locks the point, not the stand.

Our Relays conform to all requirements.

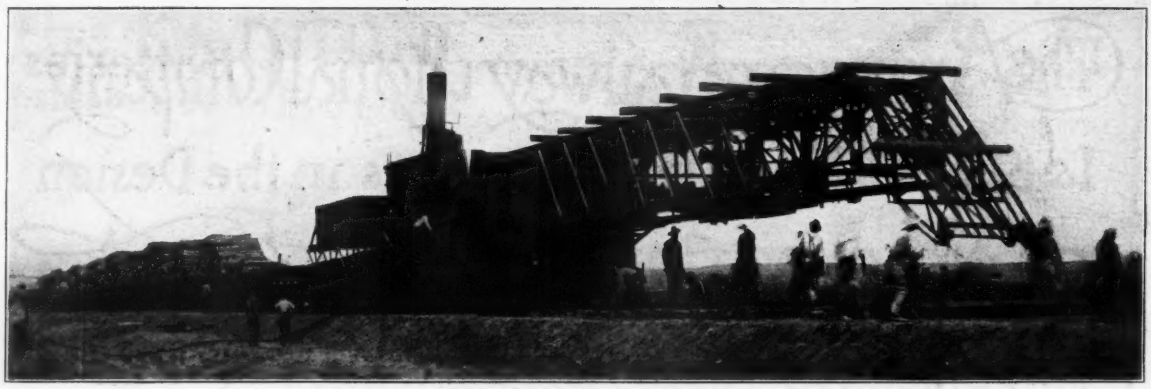


We are daily proving our claim to

"THE PERFECTION OF OPERATION"

It will pay you to Investigate.

The AMERICAN RAILWAY SIGNAL CO. Cleveland, O.



A few reasons why the Hurley Track Laying Machine is

"THE ONLY REAL MACHINE FOR LAYING TRACK"

It hauls the material train with its own power—saves one locomotive and crew.
The operator handling the machine and train is at the front—where he belongs.
It automatically distributes the rails and ties in position on the roadbed—no "tie-buckers" or "steel-men." It lays track efficiently on muddy roadbed where track could be laid only with the greatest difficulty by other methods.
The small force used has light work—it is easy to hold the force.
Each man has his own particular work to do—there is no confusion—no crowding—each man works to greatest advantage.
The machine is designed so that quarter-spiking can be done in front.
It lays track while constantly but slowly moving—is not necessary to stop to make rail connections—keeps men working at steady pace.
No matter how fast track may be laid the machine always full ties the track ahead.

Our illustrated booklet "Laying Track" fully explains all these facts. It will interest you—send for it.

HURLEY TRACK LAYING MACHINE CO., 343 S. Dearborn St., Chicago

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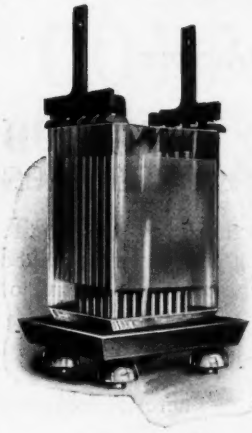
For Signal Service Employing Storage Batteries



the high grade

"National"

Storage Battery

deserves your consideration. This Battery is thoroughly well made and we believe that due to its high efficiency and economy it "can't be beat" for all round satisfactory operation.

See our Exhibit at Chicago Coliseum, March 18-23 — Space 114

You will see our large variety of types and how the elasticity of our design permits us to meet any service requirements.

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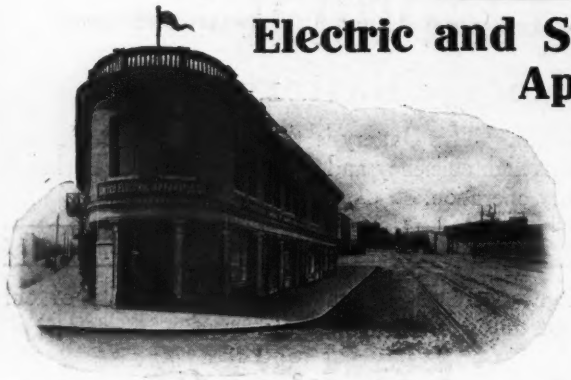
ALSO MANUFACTURERS OF THE "PEER" EXHAUST FANS AND BLOWERS

United Electric Apparatus Co. Inc.

A. A. ZIEGLER, General Manager :: Est. 1880

Engineers, Manufacturers, Designers and Contractors



Electric and Steam Railway Signaling Apparatus and Accessories

Sole authorized manufacturers of the PAT. and PAT. applied for line of perfected united contact and interchangeable apparatus of modern types.

Originators of all Bracket Type Relays.

Several patents pending. There are imitators.

Beware of Infringers.

Our apparatus meets all the requirements of the Railway Signal Association.

We manufacture for D. C. and A. C. All forms open and enclosed track and line relays, keys, switches, repeaters, indicators, annunciators, lightning arresters, crossing, tower and call bells, and a general line of accessories and supplies.

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Special Apparatus Built to Order

Type DX-DC Relay Porcelain Base

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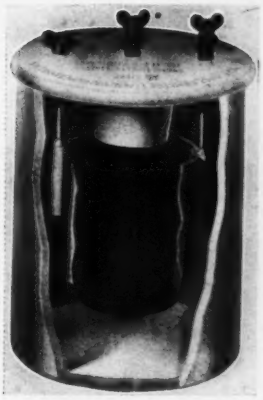
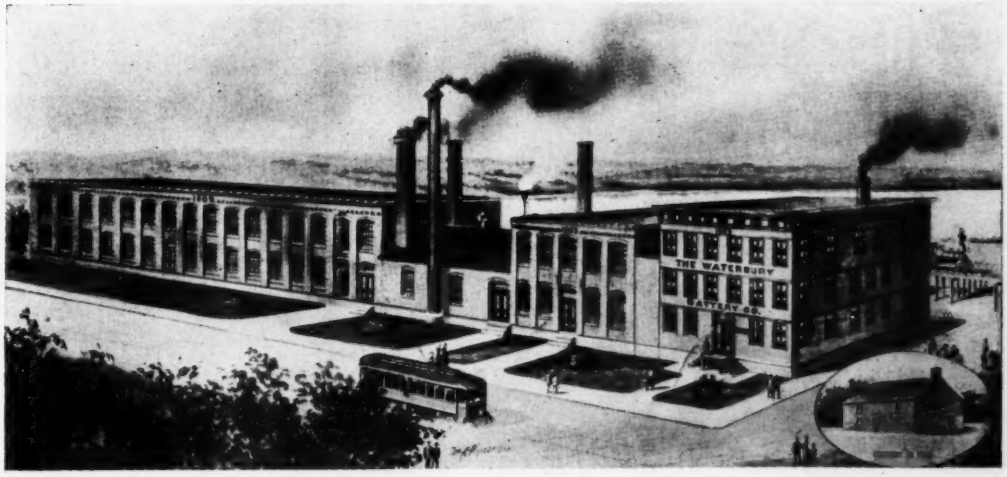
Schoenmehl's Cylindrical and Plate Type
COPPER OXIDE BATTERIES

Made in two sizes for
Railroad Signal Work

No. 4 Jar, 7⅛ x 8¾
No. 5 Jar, 6½ x 10¾





Factory of the Waterbury Battery Company, Used Exclusively for the Manufacture of Schoenmehl's Primary Batteries.

The Signal Cell Par Excellence

Schoenmehl's Primary Battery

Guaranteed Capacity Full 400 Ampere Hours

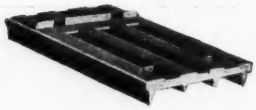
MANUFACTURED BY

THE WATERBURY BATTERY CO., WATERBURY, CONNECTICUT

DILWORTH, PORTER AND CO., Ltd.
PITTSBURGH, PA.

TIE PLATES AND SPIKES

GOLDIE PLATE

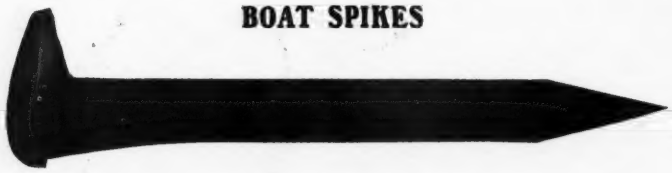


DILWORTH FLANGE PLATE

HARRIMAN PLATE

BOAT SPIKES

Standard and Special Railroad Spikes



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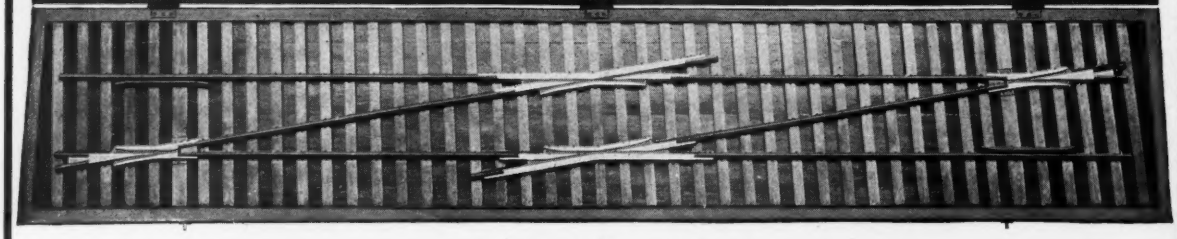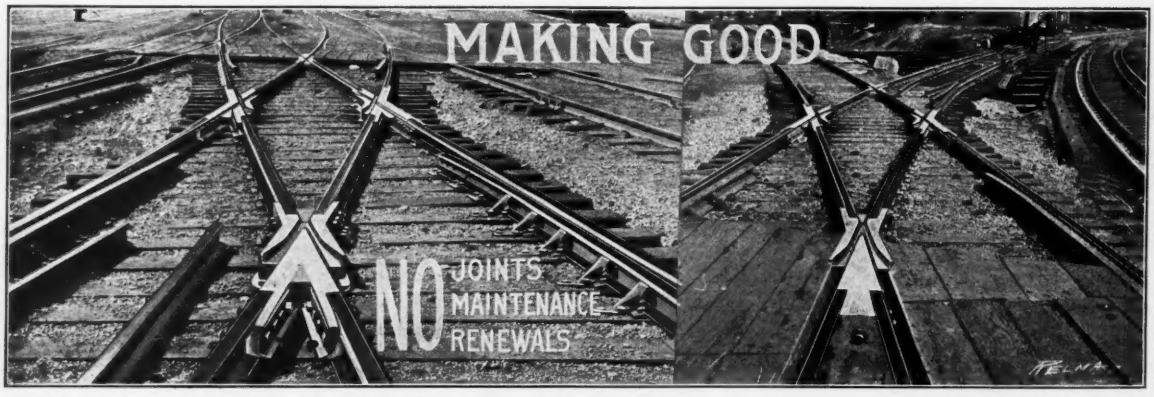
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